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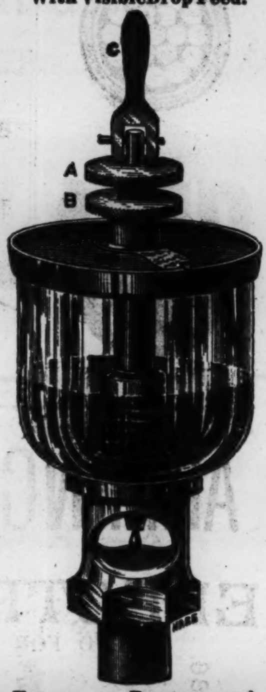

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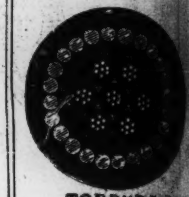

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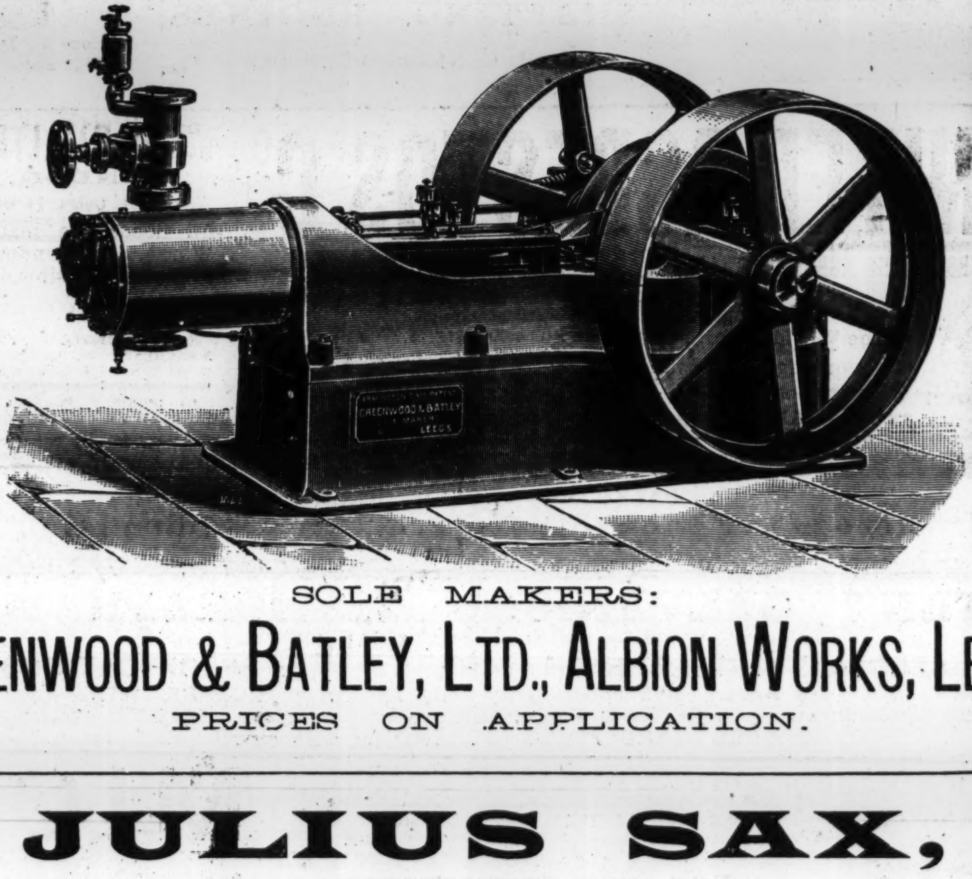

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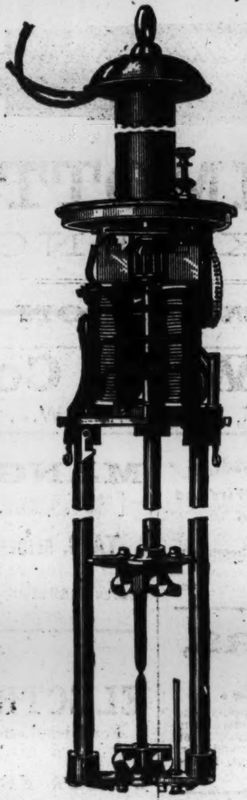

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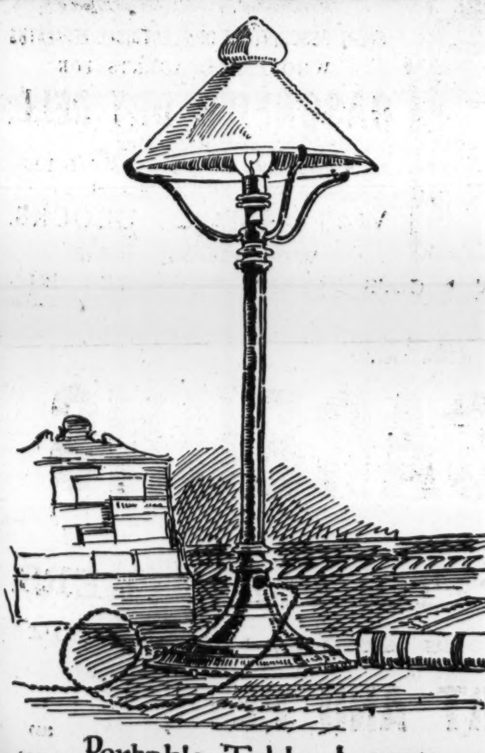

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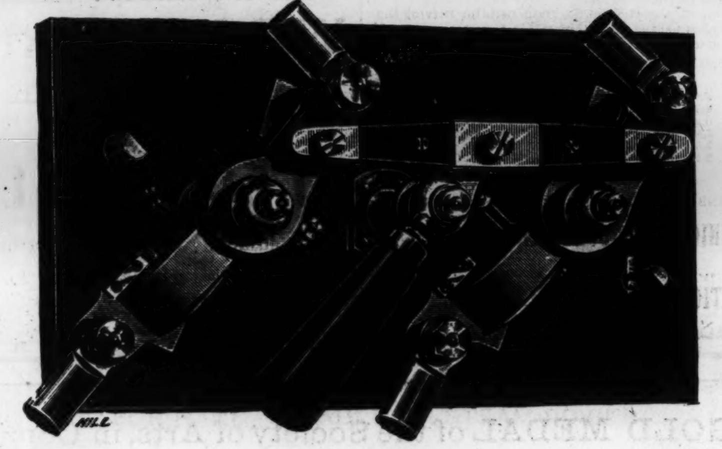

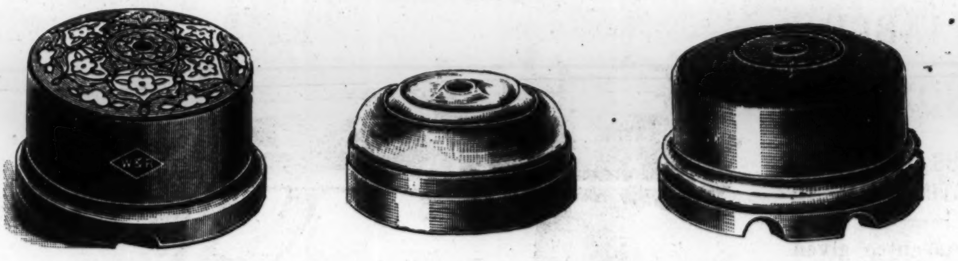

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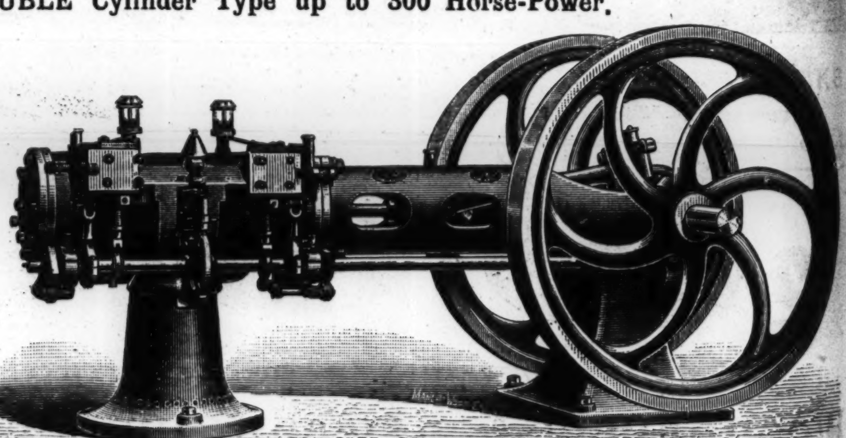

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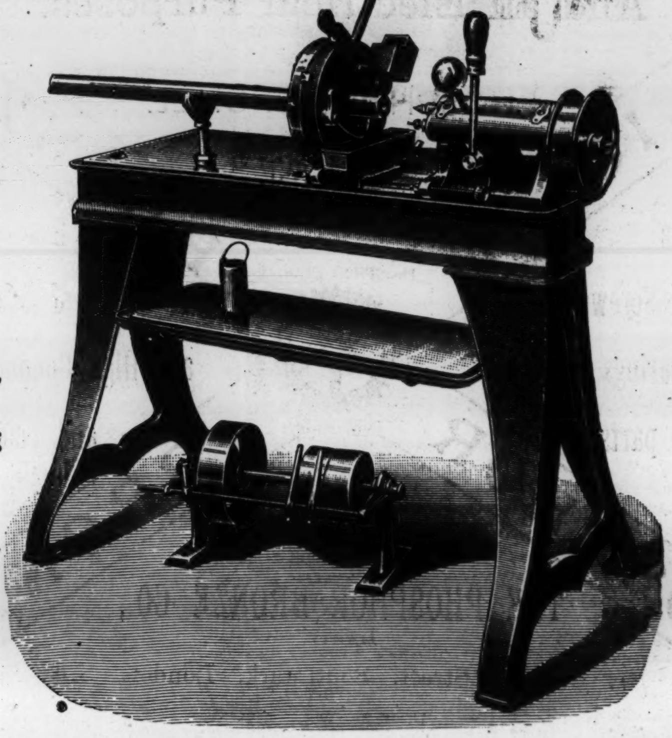

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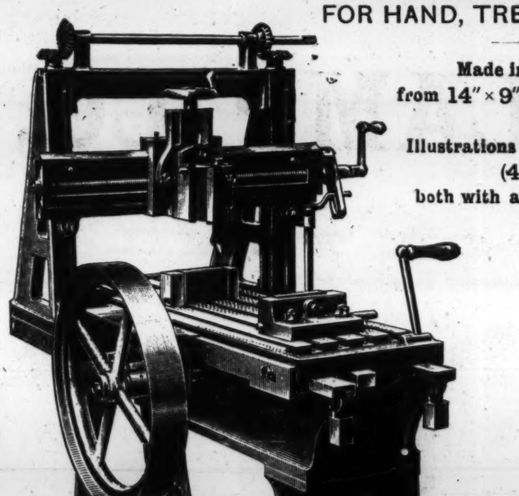

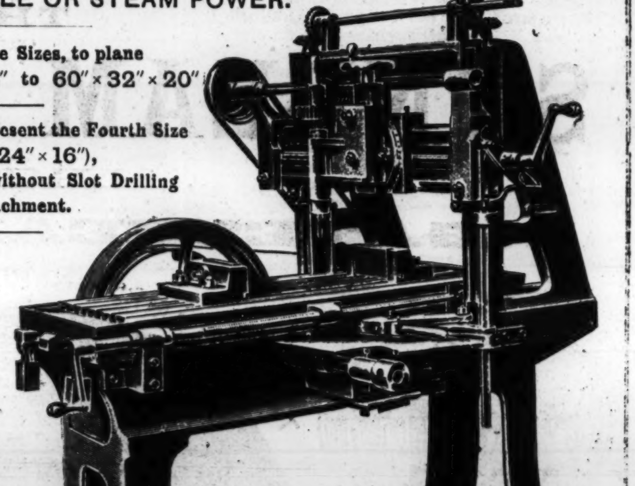

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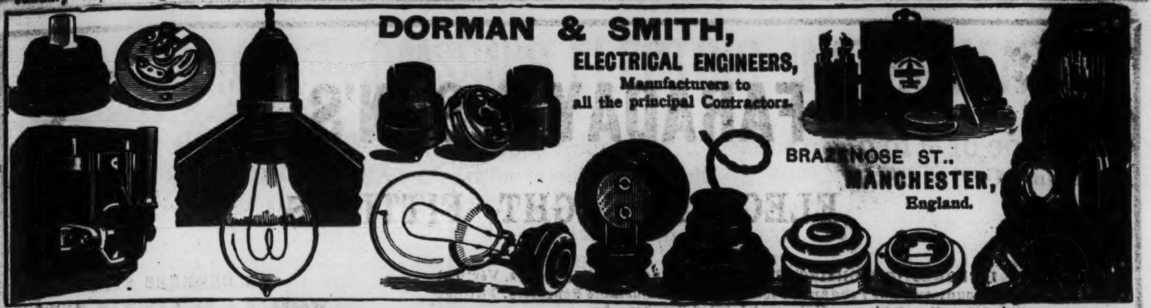

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INDEX TO ADVERTISEMENTS.

The names of Advertisers, whose announcements are ordered for a series, are entered under any one Heading in this Index free of charge but if repeated under other headings, 6d. per week is charged for each additional entry.

PAGE

- **Accumulators.**
  - Crompton-Howell Elec. Storage Co.
  - Drake & Gorham ... ...
  - J. Stiff & Sons (Boxes only) ...
  - Woodhouse & Rawson ... 7 & 13
- **Arc Lamps.**—J. H. Holmes & Co. *Sup.* 11
  - Johnson & Phillips 1
  - F. M. Newton & Co. 17
  - Planet Elec. Engineering Co. ... 5
  - Poole & White ... ... *Sup.* 17
  - Woodhouse & Rawson ... 7 & 13
- **Asbestos.**—Bell's Asbestos Co. 20, 21
  - United Asbestos Co. 3
- **Auctioneers and Valuers (Mechanical).**
  - Wheatley Kirk, Price & Goulty *Sup.* 11
- **Batteries.**
  - Birmingham Tele. Factory *Sup.* 7
  - India-rubber Co. 24
  - Johnson & Phillips 1
  - Telegraph Mfg. Co. ... *Sup.* 2
  - Woodhouse & Rawson ... 7 & 13
- **Battery Jars.**—J. Bourne & Son ... 15
  - J. Stiff & Sons ... ...
- **Bells.**—Birmingham Tele. Factory *Sup.* 7
  - Genl. Elec. Co., Ld. ... ... *Sup.* 10
  - Poole & White ... ... *Sup.* 17
  - Sheppard, Allarton & Madeley ...
  - Woodhouse & Rawson ... 7 & 13
- **Belting.**—John White & Sons ... 8
  - Webb & Sons ... ... *Sup.* 8
- **Boilers.**—Babcock & Wilcox Co. ...
  - Robey & Co. 18
- **Books.**—Berly's Elec. Directory *Sup.* 14
  - C. Griffin & Co. ... ... *Sup.* 12
  - Longmans, Green & Co. ... ...
- **Cabinet Work.**—W. M. Foxcroft ... 8
- **Castings.**—J & J. Hughes 14
  - Phosphor Bronze Co. 10
- **Chemicals.**—G. G. Blackwell 6
  - G. Boor & Co. 19
- **Dynamos.**—Andrews & Preece *Sup.* 7
  - Austin & Myers ... ... *Sup.* 4
  - Charlesworth, Hall & Co. ... ...
  - Electrical Eng. Corporation *Sup.* 9
  - Gülcher Electric Light & P. Co. 15
  - J. H. Holmes & Co. ... *Sup.* 11
  - Johnson & Phillips 1
  - Laurence, Scott & Co. ... ...
  - F. M. Newton & Co. 17
  - C. Oppermann 6
  - C. A. Parsons & Co. ... ...
  - J. & W. Roper 14
  - Stanley & Davies ... ...
  - Woodhouse & Rawson ... 7 & 13
- **Ebonite.**—Harburg I. Rbr Comb Co. *Sup.* 11
  - D. Moseley & Sons... ... ...
  - North British Rubber Co. ... 19
- **Electrical Engineers and Contractors.**
  - Acme Electric Works 17
  - Birmingham Tele. Factory *Sup.* 7
  - J. D. F. Andrews & Co. 6
  - Andrews & Preece ... ... *Sup.* 6
  - Appleton, Burbey & Williamson *Sup.* 18
  - Blakey, Emmott & Co. 6
  - R. Bolton & Co. 14
  - Brush Electrical Engineering Co. 12
  - Callender's Bitumen Tel. &c. Co. ... 13
  - Charlesworth, Hall & Co. ... ...
  - Crompton & Co. ... ... *Sup.* 20
  - Drake & Gorham ... ...
  - Elliott Bros. ... ... *Sup.* 12
  - General Elec. P. & Traction Co. ...
  - W. T. Goolden & Co. ... *Sup.* 13
  - India-rubber & Telegraph Works Co. 24
  - Johnson & Phillips 1
  - Laurence, Scott & Co. ... ...
  - Paterson & Cooper 23
  - Rashleigh Phipps & Dawson ... 12
  - C. A. Parsons & Co. ... ...
- **Electrical Engineers, &c.—*Cont.*** PAGE
  - Reid Bros. 13
  - Ernest Scott & Co. 19
  - Ronald A. Scott ... ... *Sup.* 5
  - Sharp & Kent ... ... *Sup.* 13
  - M. Holroyd Smith ... ... *Sup.* 6
  - Swinburne & Co. ... ...
  - Telegraph Mfg. Co. ... *Sup.* 2
  - Western Electric Company *Sup.* 20
  - Westinghouse Electric Co. *Sup.* 20
  - Woodhouse & Rawson United 7 & 13
- **Electric Light Carbons.**
  - Cathcart & Peto 6
  - H. & F. Chamberlain 6
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - Johnson & Phillips 1
  - Poole & White ... ... *Sup.* 17
  - Woodhouse & Rawson United 7 & 13
- **Electric Light Fittings.**
  - Appleton, Burbey & Williamson *Sup.* 18
  - Dorman & Smith 11
  - Electrical Accessories Co.... ... 5
  - Faraday & Son 12
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - The Paiste Switch... ... *Sup.* 3
  - Rashleigh Phipps & Dawson ... 12
  - Poole & White ... ... *Sup.* 17
  - B. Verity & Sons 14
  - Walsall Electrical Co. 16
  - Woodhouse & Rawson ... 7 & 13
- **Engines for Electric Light.**
  - W. H. Bailey & Co. 18
  - G. E. Belliss & Co. ... *Sup.* 2
  - Browett, Lindley & Co. ... *Sup.* 3
  - Charlesworth, Hall & Co. ... ...
  - Davey, Paxman & Co. 12
  - Greenwood and Batley 4
  - Griffin Gas Engine 8
  - Marshall, Sons & Co. 19
  - John Musgrave & Sons ... *Sup.* 4
  - Ransomes, Sims & Jefferies ...
  - Robey & Co. 18
  - Hayward Tyler & Co. ... *Sup.* 8
  - Willans & Robinson ... *Sup.* 19
- **Enamel.**—Aspinall & Co. ... ...
- **Fibre.**—David Moseley & Sons ...
- **Glass.**—Genl. Elec. Co. (G. Binswanger.) *Sup.* 10
  - Poole & White ... ... *Sup.* 17
  - Woodhouse & Rawson ... 7 & 13
- **Incandescence Lamps.**
  - Bernstein Electric Lamp Co. ... 14
  - Brush Electrical Engineering Co. 12
  - Poole & White ... ... *Sup.* 17
  - Sunbeam Lamp Co. 10
  - Woodhouse & Rawson United 7 & 13
  - Woodside Electric Co. 15
- **India-Rubber.**
  - India Rubber, G. P. & Tel. Wks. Co. 24
  - D. Moseley & Sons ... ...
- **Insulators, &c.**
  - Birmingham Tele. Factory *Sup.* 7
  - Bourne & Son 15
  - Poole & White ... ... *Sup.* 17
  - Stiff & Sons ... .
  - Telegraph Mfg. Co. ... *Sup.* 2
  - Woodhouse & Rawson ... 7 & 13
- **Iron and Steel.**—Turner Bros. ... 6
- **Lubricants.**—W. H. Willcox & Co. ... 3
- **Magnet Steel.**—G. P. Wall 17
- **Manufacturing Electricians.**
  - Birmingham Tele. Factory *Sup.* 7
  - Burckhardt & Richter 14
  - Cox & Co. 14
  - Croggon & Co. 2
  - Dorman & Smith 11
  - Elliott Bros. ... ... *Sup.* 12
  - J. T. Gent & Co. 6
  - A. B. Gill & Co. 6
  - Hartmann & Braun ... ...
- **Manufacturing Electricians.—*Cont.*** PAGE
  - King, Mendham & Co. ... *Sup.* 8
  - Laurence, Scott & Co. ... ...
  - Nalder Bros. ... ... *Sup.* 9
  - J. [illegible] & Co. ... ...
  - Poole & White ... ... *Sup.* 17
  - Price, Ta[illegible] & Co. ... *Sup.* 4
  - Julius Sax 4
  - Telegraph Mfg Co. ... *Sup.* 2
  - H. Thorpe 8
  - Walsall Electrical Company ... 16
  - Jas. White ... ... *Sup.* 1
  - Woodhouse & Rawson United 7 & 13
- **Mica.**—McGoune, Buchanan & Co. *Sup.* 12
  - F. Wiggins & Sons 8
- **Motors.**—Charlesworth, Hall & Co. ...
  - Cuttriss & Co. ... ... *Sup.* 8
  - Gülcher Electric Light & P. Co. 15
- **Patent Agents.**—H. Gardner ... 8
  - J. G. Lorrain ... .. *Sup.* 12
- **Pole Finding Paper.**—O. Berend & Co.
- **Poles.**—Joseph Aird (Wrought Iron & Steel). 2
  - Johnson & Phillips (Wood and Iron). 1
- **Porcelain Appliances.**
  - Dorman & Smith 11
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - Jas. Macintyre & Co. 14
  - Poole & White ... ... *Sup.* 17
  - Taylor, Tunnicliff & Co. ... *Sup.* 12
  - W. Wood & Co. ... ...
  - Woodhouse & Rawson ... 7 & 13
- **Porous Cells.**—J. Stiff & Sons ...
- **Projectors.**
  - Charlesworth, Hall & Co. ...
- **Railway Signals.**—Saxby & Farmer 12
- **Schools, &c.**—City & Guilds ... *Sup.* 12
  - School of Telegraphy 23
- **Screws.**—Davis & Timmins 22
  - A. Stokes & Co. ... ...
- **Stampings.**—Harold & Jenkins *Sup.* 2
- **Telegraph Engineers.**
  - Birmingham Tele. Factory *Sup.* 7
  - Johnson & Phillips 1
  - Julius Sax 4
  - Telegraph Mfg. Co. ... *Sup.* 2
- **Telephones.**
  - Consol. Tel. Const. & M. Co. *Sup.* 6
  - Universal Telephone Co. ... *Sup.* 8
- **Tools, Lathes, &c.**
  - Chas. Churchill & Co. 17
  - Selig, Sonnenthal & Co. 9
- **Tubes.**—Joseph Aird 2
- **Turbines.**—F. Nell ... ... *Sup.* 14
- **Wire (covered).**
  - Birmingham Tele. Factory *Sup.* 7
  - Fowler-Waring Cables Co. ...
  - W. T. Glover & Co. 2
  - W. T. Henley's Telg. Works Co. ... 4
  - London Electric Wire Co. *Sup.* 1
  - Okonite Company ... ... *Sup.* 3
  - Phillips Bros. 23
  - Poole & White ... ... *Sup.* 17
  - W. Rickard 8
  - Telegraph Mfg. Co. ... *Sup.* 4
  - United Electric Wire Co.... ... 8
  - Woodhouse & Rawson United 7 & 13
- **Wire (uncovered)**—Davis & Timmins 22
  - Ramsden, Camm & Co. 15
  - F. Smith & Co. 3
- **Wire Covering Machinery.**
  - T. Barraclough & Co. 6
- **Wood Casings.**—
  - Genl. Elec. Co., Ld. (G. Binswanger.) *Sup.* 10
  - J. F. & G. Harris ... ... *Sup.* 19
  - Poole & White ... ... *Sup.* 17
  - Vigers Bros. ... ... *Sup.* 12
  - Woodhouse & Rawson United 7 & 13

BOOK ADVERTISEMENTS APPEAR ON Page 14 OF SUPPLEMENT.

MISCELLANEOUS ADVERTISEMENTS *relating to Situations, Articles for Sale and Wanted, &c., &c., appear on Sup. 11 (middle of paper.)*

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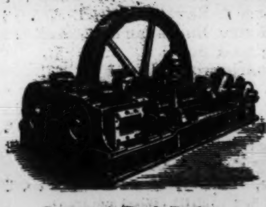

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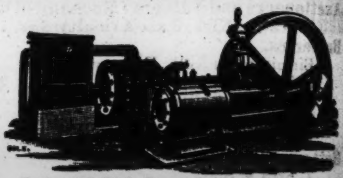

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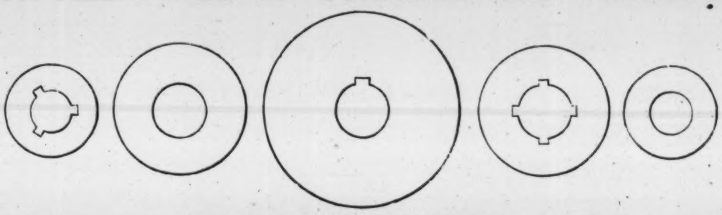

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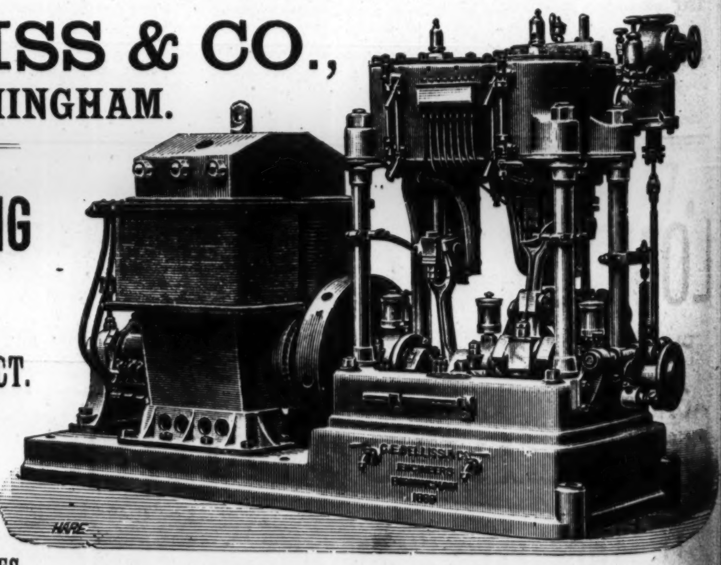

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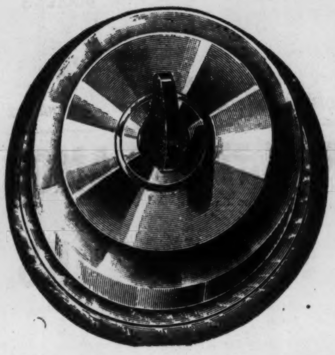

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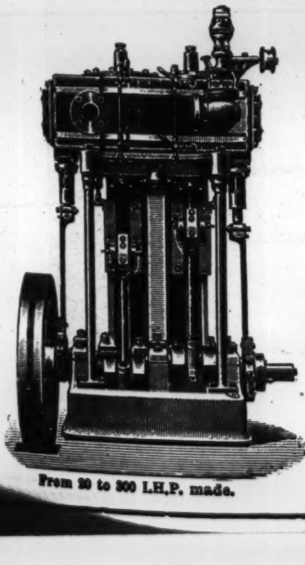
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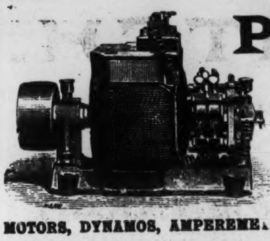

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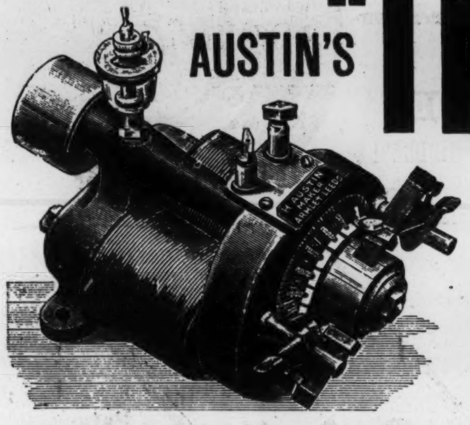
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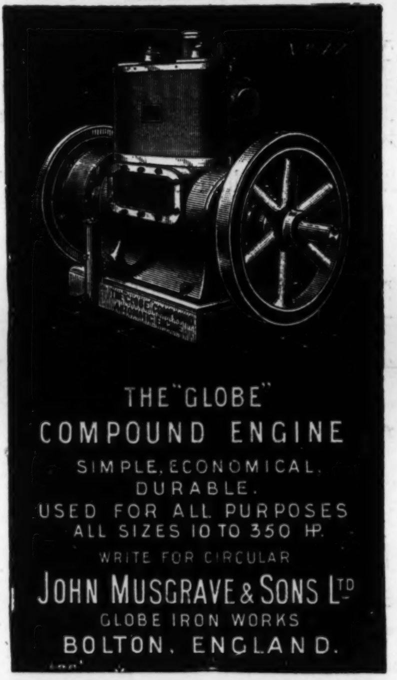

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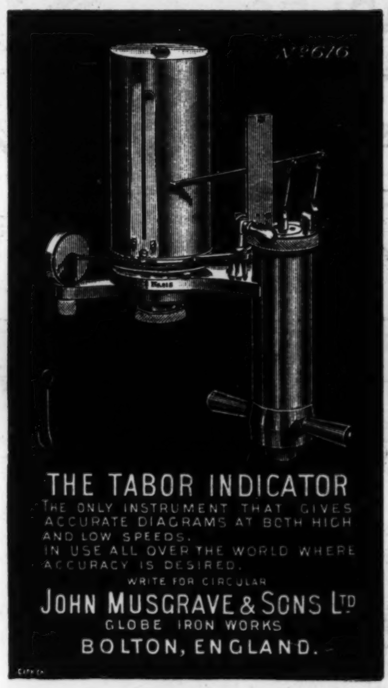

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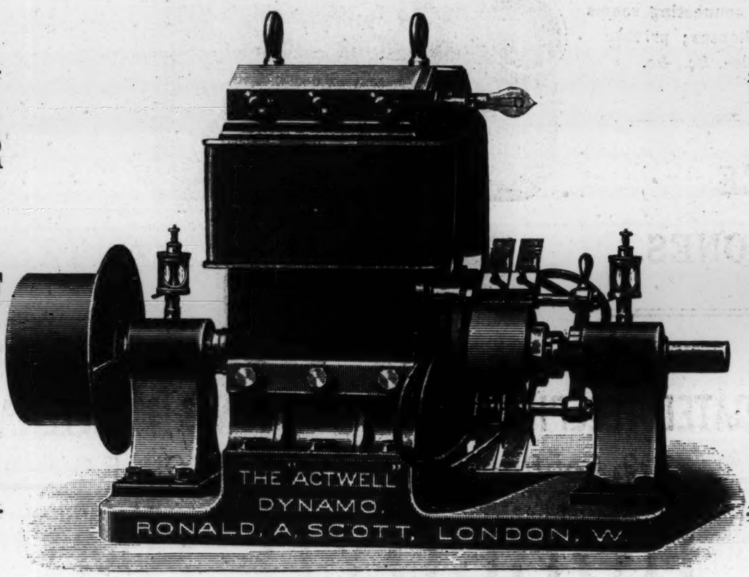

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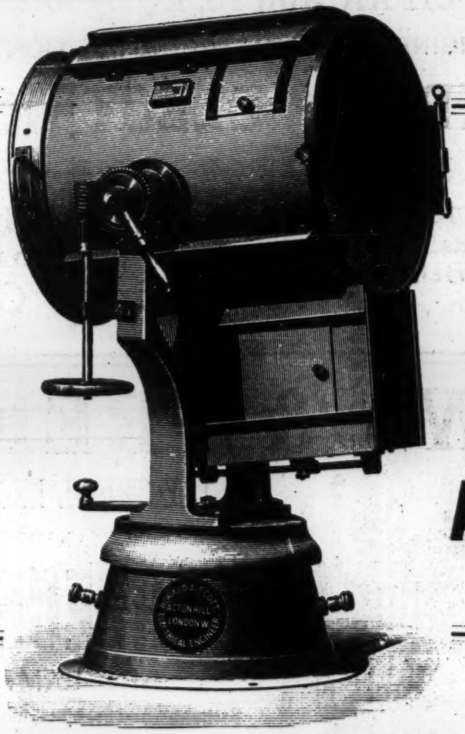

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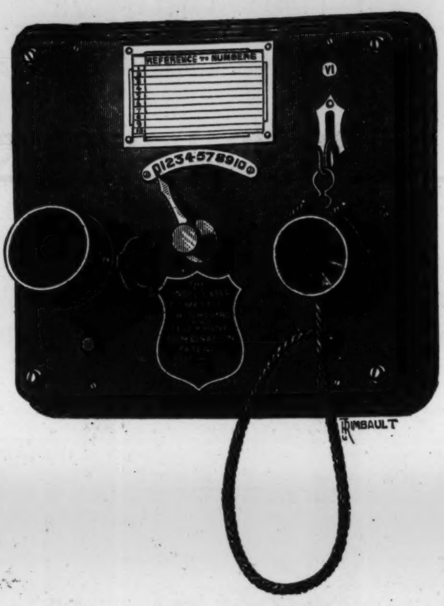

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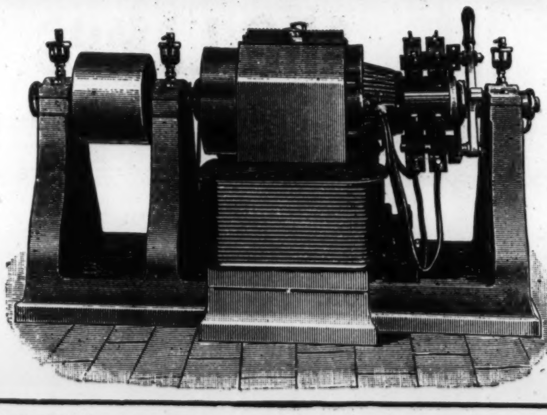

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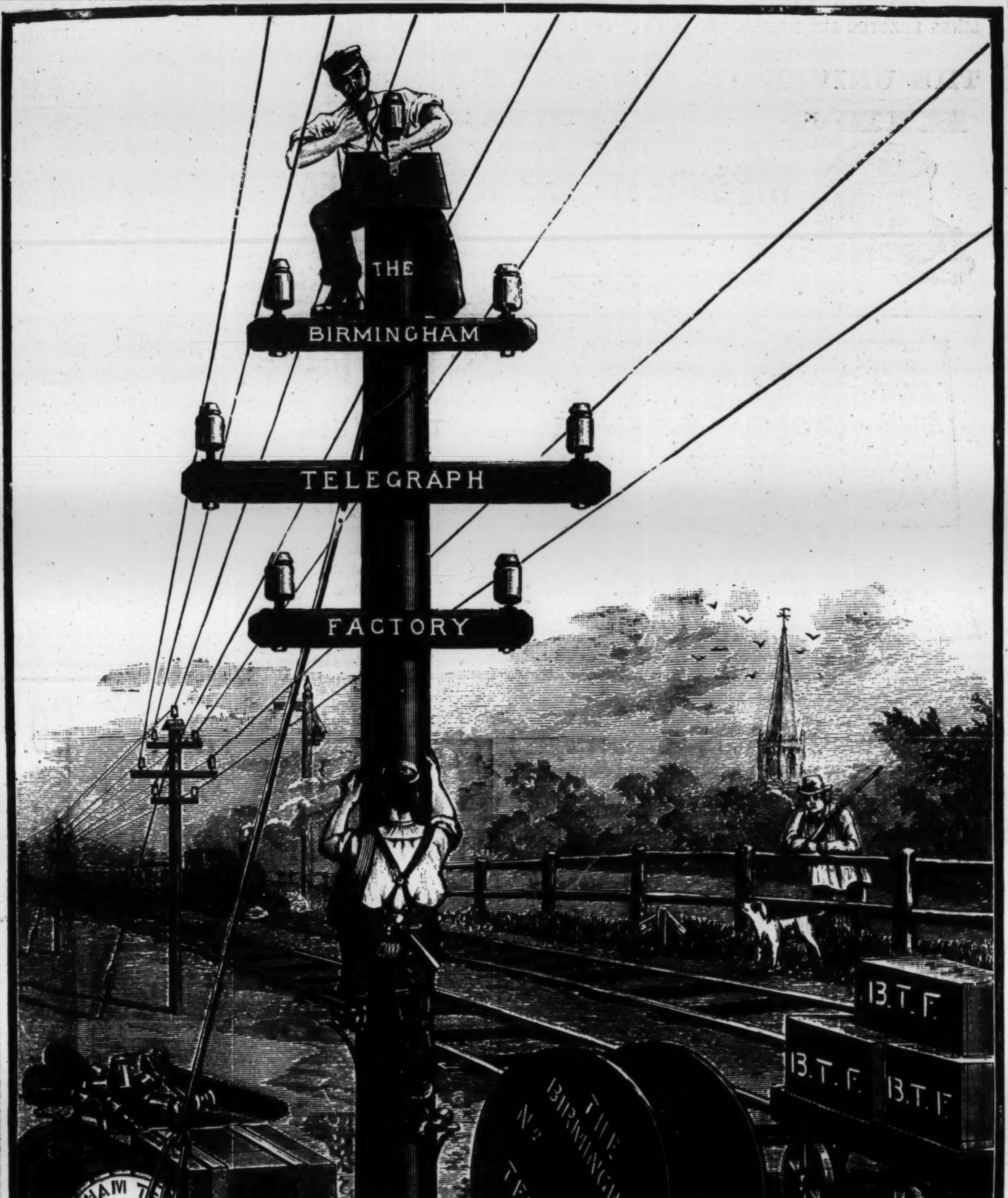
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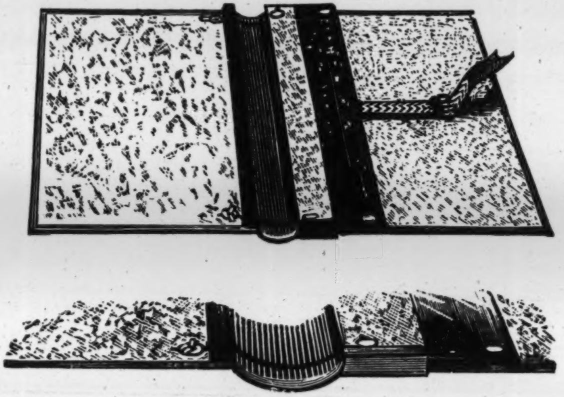

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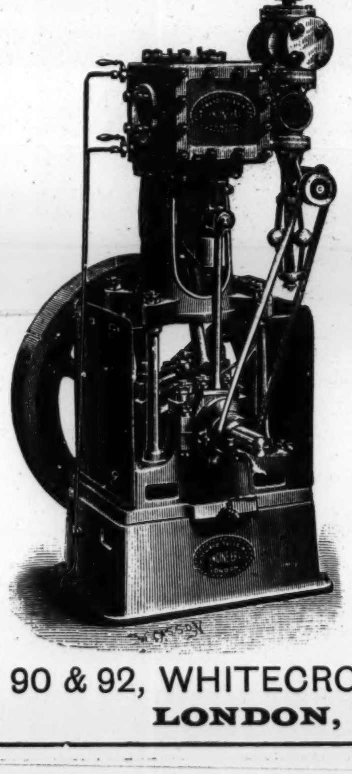

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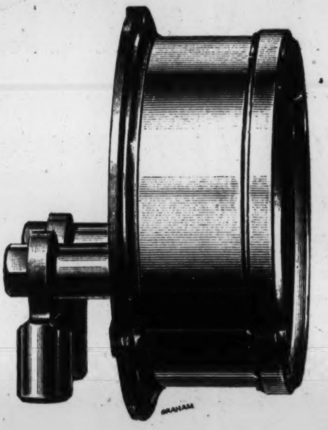

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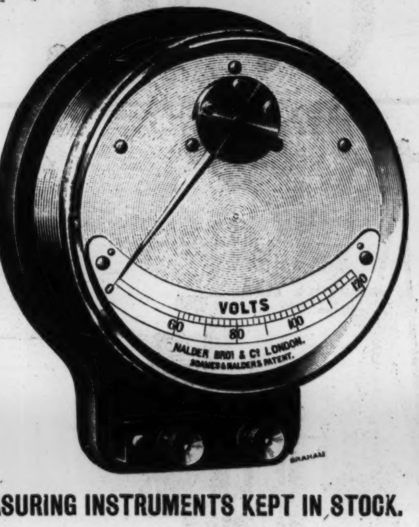

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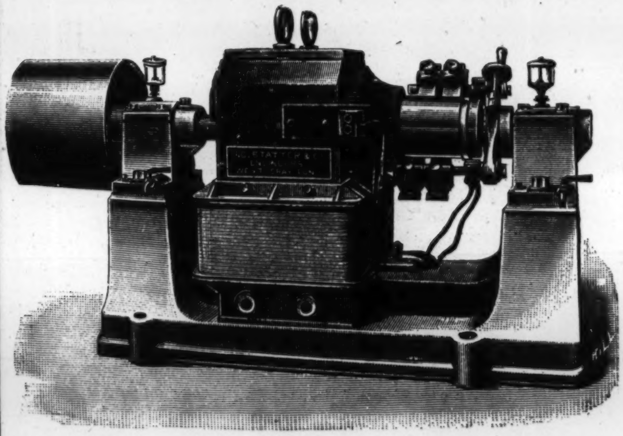

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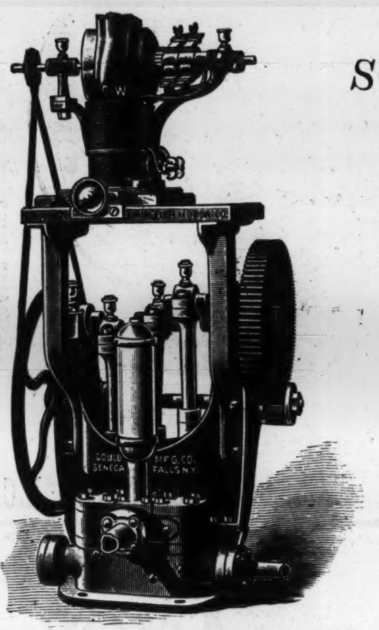
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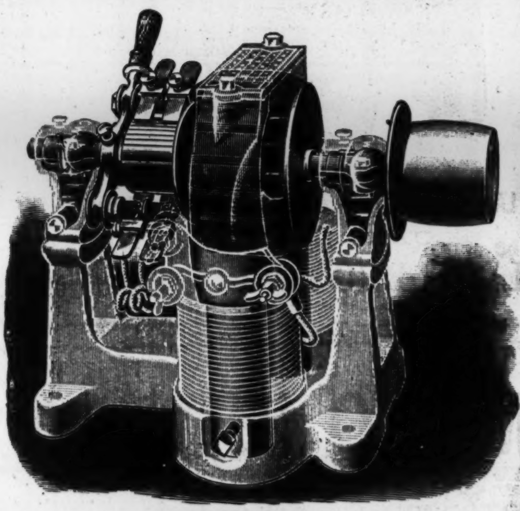

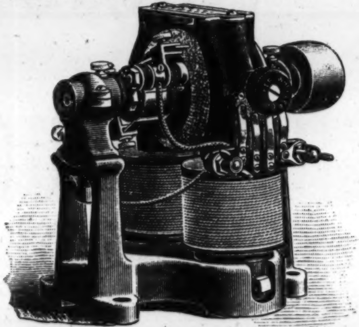

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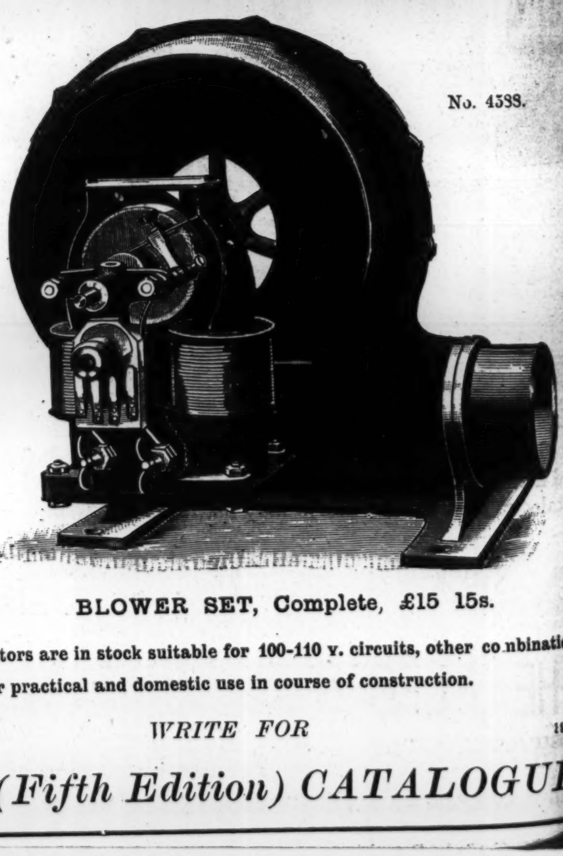

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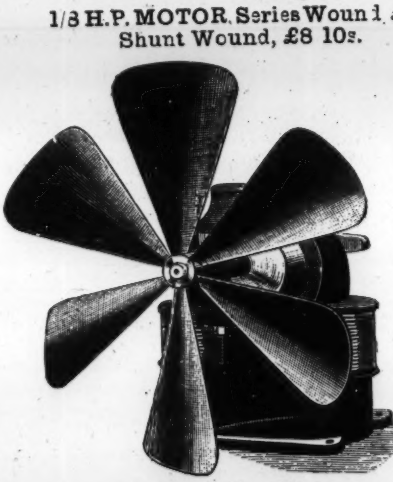

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ELECTRICAL REVIEW.

VOL. XXVIII. JANUARY 16, 1891. No. 686

CONTENTS:

	PAGE
Jablochkoff's Distribution Patent Extension	65
Electric Lighting in the City	66
The Liquidation of Companies	67
The French Elmore Company	68
The Largest Arc Lignting Station in the World	70
The St. James's and Pall Mall Electric Light Company (*illus.*)	74
Proceedings of Societies:—	
The Institution of Electrical Engineers (*illustrated*)	76
Alleged Primary Battery Swindlers	81
Notes	81
City Notes, &c.:—Elmore's French Copper Company	87
Woodhouse and Rawson United, Limited	88
The Direct United States Cable Company	89
Traffic Receipts	89
Share List of Electrical Companies	90
Bergmann's New Connector for Electrical Conductors (*illus.*)	91
Accumulator and Horse Traction	91
Direct-Driven Phœnix Dynamos	92
More Post Office Warfare	92
Testing Arc Lamps (*illustrated*)	93
Abstracts of Published Specifications	94
Correspondence:—Electric Light on Shipboard	94
Curious Phenomena (*illustrated*)	95
The City and South London Railway	95
Is Science Disciplined Knowledge, or is it Something Else?	96

JABLOCHKOFF'S DISTRIBUTION PATENT EXTENSION.

"IN the matter of certain letters patent, granted to Paul Jablochkoff, of Paris, Boulevard de Strasbourg, 23, engineer, for the invention of 'A new process of producing and dividing electric light and apparatus therefor,' and bearing date the 22nd day of May, 1877, and numbered 1,996. Notice is hereby given, that it is the intention of the Electrical Engineering Corporation, Limited, in whom the said letters patent are now vested, to present a petition to Her Majesty in Council, praying that the said letters patent may be extended for a further term. And notice is hereby further given, that on the 19th day of February next, or on such subsequent day as the Judicial Committee of Her Majesty's Privy Council shall appoint for that purpose, an application will be made to the said Committee for a time to be fixed for hearing the matter of the said petition, and any person desirous of being heard in opposition to the prayer of the said petition must enter a caveat to that effect in the Privy Council Office, on or before the said 19th day of February next.—Dated this 24th day of December, 1890.—FAITHFULL and OWEN, 11, Victoria Street, Westminster, Solicitors for the Petitioners."

So runs a notice in the London *Gazette* of the 9th inst. It may not be generally known to our readers that the patent in question is that upon which the Electrical Engineering Corporation, Limited, has already prevailed upon the following firms to work under licence:—the Anglo-American Brush Electric Light Corporation, Limited; Crompton and Company, Limited; S. Z. de Ferranti—London Electric Supply Corporation, Limited; W. T. Goolden and Company; Hammond and Company; Wilson Hartnell; Johnson and Phillips; Nalder Bros. and Company; Paterson and Cooper; Ernest Scott and Company; Siemens Bros. and Company, Limited; J. G. Statter and Company, Limited, and Laurence, Paris and Scott, Limited. The Corporation also warns the public against infringement.

Now, our views on the subject of monopolies are so well known that it is needless to recapitulate them here, but as we have always held that the patent of Gaulard and Gibbs could not prevent the employment of other forms of transformers, a contention which was shown to be correct by a decision in the law courts, we are equally of opinion that Jablochkoff's patent, like many others of its kind before and since, is a mere mention, without development, of distribution by transformers.

In these days of patent piracy a real inventor stands but little chance of developing his invention, unless, like Graham Bell's telephone receiver, the initial effort is of so simple and complete a nature in itself, that most attempts at so-called improvement are mere artifices to get outside the claims of his specification rather than useful additions to an apparatus already nearly perfect. No sooner is a specification made public than numbers of persons who make "improving" it a business, are ready, if the invention shows real promise, to "ring the changes" upon it there and then. Probably all the twistings and turnings of the original idea would occur in course of time to the inventor himself, but, no! this process of evolution is denied him; the work which he could well complete is immediately pounced upon by others who desire a finger in the pie. Let it not be understood that we deprecate the desire to make everything as perfect as possible, but let it be with the genuine idea to improve, and not for the purpose of eventually extracting black mail when a favourable opportunity arises.

With an inventor who really makes some great discovery, such as Varley's happy thought of the reaction principle of the dynamo, we have every sympathy, and no one would begrudge such a discoverer all the honours which a grateful community thought fit to bestow upon him, or the riches which might accure to him through the general adoption and use of his rights during the term of years granted as the life of a patent; but we have no patience with the attempts which are continually being made in all branches of electrical engineering to secure monopolies on patents which are known to have been anticipated by other workers in the same field.

Neither do we feel very favourably disposed towards those so-called inventors who, having made some difference of construction in an apparatus without introducing any novel feature in its working consider themselves free to do as they please in the face of existing and workable patents of the same kind, even if these latter be not absolutely new inventions. To illustrate our meaning let us go back to the time of Gaulard and Gibbs. When it was found that in their transformer system there was something more than a germ of usefulness, improvers sprang up with mushroom-like growth. Probably poor Gaulard would, had time admitted, have tried transformers with closed magnetic circuits, even if he had not hit upon that hybrid compromise between the open and closed magnetic circuit, which an ardent student of natural history seems to have discovered through watching the habits of a little quadruped with round ears, and the upper part of his body covered with prickles. Now, although we contend that the designers of these various appliances have a right to use and sell their wares, yet the Gaulard and Gibbs patent would never have been overthrown had the proprietors allowed the new comers to go on in their way free from interference. It was a matter of the inventor of an improvement overthrowing a prior improvement, and now it seems rather paradoxical that the one who upset the patent of Gaulard and Gibbs should consent to work under license from the owners of Jablochkoff's visionary scheme. Gaulard and Gibbs should have been contented to exploit their own apparatus and leave others alone; neither they nor any of the workers in the domain of distribution by transformers had a patent which, in our opinion, would stand the brunt of a test action.

Having thus briefly, but freely delivered ourselves on inventors and inventions, we will proceed to the matter at issue. No doubt the subject will receive considerable attention, but we are credibly informed that a large number of the firms composing the trade have already been granted licenses by the E. E. Corporation on such excessively reasonable terms that we hardly think the trade, as a whole, is likely to oppose the application. This may be thought a very selfish way of looking at it; but in these days when electrical firms are threatened with such a large amount of litigation on vital points, they consider it necessary to reserve their energies for fighting those attempts which seriously imperil the welfare of the trade.

The following questions, however, suggest themselves :—

1. Is it morally right that the holders of the Jablochkoff patent should have their monopoly extended ?

2. Did Jablochkoff's invention, which was a mere mention, without development, of distribution by transformers, entitle the holders of it to levy royalties for an extended period ?

3. Have the existing holders of Jablochkoff's patent treated the trade fairly and liberally ?

We will answer the last question first, and say certainly they have done so, and consequently have probably received very little money, and from this point of view alone the Corporation has some grounds in petitioning for an extension.

With regard to the first two questions we have advisedly used the words "morally right," because we believe that it would be found if anyone spent sufficient money on litigation, that not one of the inventors who made this form of distribution possible, has got a patent which would stand; but nowadays there is a growing disposition in the electrical trades to treat these matters in an equitable manner and to pay royalties (provided they are levied at a low rate) to the holders of patented inventions which really have been of service to the trade, and no one could deny that distribution by transformers has been of real service. This feeling, however, does not seem quite logical, for we find that the same people who are contented to stay their opposition to an extension of Jablochkoff's patent, are ready to fight, tooth and nail, against the claims of Lane-Fox.

When one considers that the inventors of almost all the important improvements connected with electric lighting have in most cases gone entirely unrewarded, one cannot help feeling a sympathy with, and a desire to help those who have really done something and who are perhaps unfortunate in the manner their patent was drafted. We leave the trade, in this case, to decide upon the policy to adopt.

ELECTRIC LIGHTING IN THE CITY.

EVERY public scheme or undertaking is, of course, open to divergent criticism, no two critics basing their opinions on the self-same ascertained facts or data; still, as a rule, in comparing independent criticisms, a general similarity of purport or parallelism will be discovered between them as to the feasibility of the projects, while any great departure from coincidence will only arise when the commercial and financial prospects come under discussion.

This is not the case between the remarks upon the City lighting, published respectively in the *Financial News* and *Money*. The one paper—part of whose article we printed last week—makes the success of the scheme for improving the lighting of the streets in the City an undoubted certainty; depicts it in language financial papers so well know how to employ, filled with delightful suggestions for future dividends of over 10 per cent., and other baits likely to raise the hopes and inflame the minds of the investing public prior to bringing out the proposed companies which are eventually to take over the concessions. If this article gives too glowing an aspect to the vision of future prosperity, it is right in its judgment of not raising any suspicions that the contractors can fail to accomplish the engineering portion of the undertaking. Our other contemporary, on the other hand, takes a most adverse and pessimistic view of the whole matter; in fact, its leader is a counterblast to the above statements, criticising each sentence to throw ridicule thereon—we think just ridicule, as far as the commercial part is concerned, for it is difficult to see whence a dividend can be extracted from the following set forth advantage: "This new and important departure of lighting by electricity the whole of its thoroughfares, *stands* foremost and *alone* among the cities of the world." We are at one with *Money* in regard to "artfully baited traps" to catch the unwary investor, and in the advice that "they are best left severely alone," and we must agree with its opinion that, if the capital to be sunk for lighting the City is to amount to £1,000,000, the investors will have to wait for a reasonable return on the money expended until the return of the Greek Kalends.

The rent of lamps for lighting thoroughfares will be somewhat over £20,000 per annum; and the consumption of current will be approximately 680,000 units per annum. Supposing the capital invested was £100,000 instead of £1,000,000, there would not even then be much to spare for interest after all outgoings were discharged and depreciation provided for. Whatever financial success is to attend the scheme will be derived from private consumption. How will City people avail themselves of the use of electricity when it is brought to their doors? The City is essentially an early place where comparatively there is little night work, always excepting at the printing establishments, consequently it is a question whether warehousemen would light their existing premises by electricity in place of the present gas burners; some offices might do so, but we should not be sanguine as to the satisfactory result from that source, and private dwelling-houses being few in the City little could be expected from that class of demand. The bulk of the consumption would have to come from public establishments, banks, and large commercial institutions.

Some of these buildings are already lighted by private installations, and more would use electricity, were there no attendant inconvenience in using the current. In all probability the premises that are at present fitted with electric light would, before long, be supplied by the contractors for the City lighting, for it can hardly be denied that engines and other apparatus are undesirable machinery to have working in private buildings, and cause some trouble and expense in maintaining. The companies may rest assured that all this class of consumption will, in the end, be supplied from their mains.

The criticism on the financial outlook is fair and justifiable; not so that on the engineering fulfilment of the scheme, which it must be confessed is outrageously silly and behind the time; it reads like unto certain papers we have gone through during some American controversy, the distinguishing feature of which was that neither of the two sides could see the least value in the statements made by the other.

Because the London Electric Supply Corporation have unfortunately, for themselves, been burnt out, and the Deptford station is not immediately all that could be wished, the article calmly concludes that the concessionaires for the City lighting are about to tempt fate and fortune by trying their 'prentice hands on the job, quite undeterred by former fiascoes.

We shall not make any further comment, but add an extract, from which every one can form his own conclusion:— "In plain words, there is ample evidence that the electric light apostles are again letting their imaginations run away with them. The simple truth is that an enormous amount of money is going to be squandered in pursuance of a costly and impracticable fad," and "in face of the constant breakdowns and fatalities caused by the electric light, the streets are to be handed over to such an insidious and treacherous enemy. It is another case of 'much cry and little wool.' It is merely bounce, and nothing more."

The article totally ignores the fact that other companies are supplying the electric current successfully, in spite of the so-called fiasco on the part of the London Supply Corporation.

THE LIQUIDATION OF COMPANIES.

HITHERTO it has been a matter of great difficulty for shareholders and creditors of companies in course of winding up to obtain access to the accounts of liquidators, the statement made at the final meeting as to the manner in which the winding up has been conducted and the property of the company disposed of being all the information usually obtainable. A change in this direction has now taken place, and the Companies' (Winding-up) Act, 1890, which came into operation on the 1st inst., provides that at such periods as may be prescribed, the liquidator of a company shall send to the Registrar of Companies an account of receipts and payments, and that these shall be open to the inspection of creditors, contributories, or their agent, upon payment of a certain fee. In the absence of any special direction from the Board of Trade, the statement is to be sent twice in each year, the first to be filed within 30 days from the termination of the first year during which the liquidation proceedings have been pending.

The statement is to contain details of all the liquidator's receipts and payments on account of the company, but bank transactions as between the liquidator and the bank, and payments or receipts on account of investments made by or on behalf of the liquidator, are to be inserted in the columns provided for that purpose, and not in the columns for "other receipts and payments." Each receipt and payment must be entered in the account in such a manner as sufficiently to explain its nature. The receipts and payments are severally to be added up at the foot of each sheet, and the totals carried forward to the next sheet without any intermediate balance, so that the gross totals shall represent the total amounts received and paid by the liquidator respectively. When the liquidator carries on a business, a trading account must be forwarded as a distinct account, and the totals of receipts and payments on the trading account must alone be set out in the statement. Petty expenses must be entered in the statement or trading account in sufficient detail to show that no estimated charges are made. Where property has been realised, the gross proceeds of sale are to be entered under receipts in the statement, and the necessary disbursements and charges incidental to sales must be entered as payments.

Where dividends or instalments of composition are paid to creditors, or a return of surplus assets is made to contributories, the total of each dividend or instalment must be entered as one sum. Thirty days are allowed for filing the statements, and a liquidator not complying with the requirements of the Act renders himself liable to penalty not exceeding £50 for each day during which the default continues.

If it appears from any such statement or otherwise that any liquidator of a company has in his hands or under his control any money representing unclaimed or undistributed assets of the company which have remained unclaimed or undistributed for six months after the date of their receipt, the liquidator is to forthwith pay the same to the companies' liquidation account at the Bank of England. Every such liquidator shall be entitled to the prescribed certificate of receipt for the moneys so paid, and that certificate shall be an effectual discharge to him in respect thereof.

For the purpose of ascertaining and getting in any money payable into the Bank of England in pursuance of this section, the like powers may be exercised and by the like authority as are exerciseable under section 162 of the Bankruptcy Act, 1883, for the purpose of ascertaining and getting in the sums, funds, and dividends referred to in that section.

Any person claiming to be entitled to any money paid into the Bank of England in pursuance of this section may apply to the Board of Trade for payment of the same, and the Board of Trade may, on a certificate by the liquidator that the person claiming is entitled, make an order for the payment to that person of the sum due. Any person dissatisfied with the decision of the Board of Trade in respect of any claim thus made in pursuance of this section may appeal to the High Court.

A special search room has been provided at Somerset House, and a fee of half-a-crown is charged for the inspection of any such statement, but any person who, for the purpose of inspecting, shall untruthfully state himself to be a creditor or contributory, will be considered guilty of a contempt of court, and will be punishable accordingly, on the application of the liquidator or of the official receiver. It would be to the public advantage if the authorities would themselves take steps for the enforcement of the penalty for the noncompliance with the provisions of the new Act, instead of leaving the initiative to any member of the public. Many of the companies registered seem quite to ignore the fact that an annual return is required to be filed, and it is only occasionally that proceedings are taken; a private individual naturally objecting to pose as a common informer, and as a consequence, such companies continue in default until after existing for a lengthened period they are struck off the register.

THE FRENCH ELMORE COMPANY.

THE statutory meeting of the French Elmore Company was held on Friday last. We publish a report of the proceedings in another column. The shareholders might have reasonably expected that some definite information of the progress of the process would have been furnished, but they had to be content with the vaguest generalities. Incidentally we find confirmation of our views that other company issues were contemplated. The French Company retains the wire business in its own hands "instead of disposing of the same to a sub-company as was intended" The rest of the proceedings was largely composed of exchanges of compliments between the directors and Monsieur Sécretan. The directors congratulate the shareholders on their good fortune in having secured his very valuable services, and M. Secretan is glad to have the opportunity of expressing publicly the honour the directors have conferred upon him. The directors have certainly "put their money on" M. Secretan. They had arranged for works in the south with water power, but M. Secretan prefers the north with steam power. The directors contemplated working on a small scale, but nobody will be surprised to learn that M. Secretan prefers a grand scale, and the directors double the working capital accordingly. If the company succeeds, the directors will be entitled to the credit, because they had the good judgment to select M. Secretan as general manager; if by any mis-chance it should fall short of the expectations raised, it will be all the fault of that M. Secretan, and the directors will simply be responsible for a slight error of judgment—an error which will be quite excusable when the recommendations they received are taken into account. One of the shareholders, who had the temerity to make remarks throwing some doubt on M. Sécretan was effectually silenced by Mr. F. L. Rawson, expressing the high opinion his firm—Woodhouse and Rawson—had of M. Sécretan's capacity. When Mr. F. L. Rawson heard there was a chance of M. Sécretan coming as manager, he exclaimed, "The future of the company is assured," so that there was apparently some doubt about the success of Elmore by itself, but Elmore-cum-Sécretan is irresistible. Proofs of M. Sécretan's energy are very well in their way. Nobody need doubt his energy. The shareholders of the French Company do not need energy in the establishment of a factory which absorbs their money. What they do need is the exercise of judgment which will keep the money until they can see that an English factory pays.

The Gutta-percha Famine.

THE paper read by M. Grawinkle before the Electro-technical Society of Berlin, and to which we referred in a previous issue, contained a not unimportant corroboration of the statements made by M. Sérullas, in the series of articles published in *La Lumière Electrique*, as to the deterioration in the quality of gutta-percha now imported. M. Grawinkle ascribes the inferior insulation now obtained in gntta-percha covered wires as compared with that observed in the manufactures of a few years ago, to the indifferent quality of the gums now made use of. We presume that M. Grawinkle speaks with some authority, as he bases his remarks on an elaborate series of tests, conducted over a long period, on the German underground systems. It has been stated that two manufacturing companies were compelled to abstain from competing for certain work owing to the high price and difficulty of obtaining good gutta-percha, and we are given to understand that an Italian firm has been obliged to pay, in the London market, considerably more than five shillings per pound for gutta-percha of a satisfactory quality, and even at this price only comparatively small quantities could be obtained. From the *India-Rubber and Gutta-Percha Journal* we gather that the imports of gutta-percha in 1889 into the United Kingdom, from the British East Indies (we suppose that Assam, Ceylon and Burmah are here included) and British Guiana, have largely increased, while there appears to be a considerable diminution in the supply from the Straits Settlements. This, if we correctly interpret our contemporary's statistics, would indicate a still descending scale in the quality of the material introduced to this country. The period seems to be rapidly approaching when the only practical solution of the difficulty will be found in the employment of India-rubber for underground and submarine cables.

The Anglo-French Telephone Cable.

THE *Bulletin de la Société Internationale des Electriciens* publishes, in its issue for December, 1890, some particulars as to the telephone cable about to be laid between Sandgate and Cape Gris-Nez. The cable contains four separate cores. Each conductor consists of seven copper wires stranded, and weighs 160 lbs. per knot. The dielectric of each core is composed of three layers of gutta-percha alternating with layers of Chatterton compound, and weighs 300 lbs. per knot. Our contemporary has been led into a curious error with regard to the temperature at which the core should be tested. It is stated that the conductor should have a resistance of less than 7·632 ohms, and more than 7·478 ohms per knot, at a temperature of 45° Fhr., and that the insulation resistance must not be less than 500 megohms per knot at a temperature of 45° Fhr. In a footnote the author of the paragraph mentions that in a communication to the British Association the temperature is given as 75° Fhr., which, it is remarked, must be a mistake. We cordially agree with him that there must be a mistake somewhere. The equivalent of 45° Fhr. is given as 25° centigrade; as a matter of fact, it is 7·2° centigrade, while that of 75° Fhr. is 23·8° centigrade; this might also be reckoned as another mistake. We do not wish to appear captious, but the idea of testing core after immersion for 24 hours in water at a temperature of 45° Fhr. is too good a joke to let pass.

The Anglo-French Telephone Line.

THE *Times* in its issue for January 12th, contains a long article under the above heading, and the occasion is taken advantage of to reproduce the history, in a somewhat condensed form, of submarine telegraphy. To non-professional readers the article will prove of interest, but we take exception to the implication that Morse, in 1842, when he insulated a wire with India-rubber and tarred hemp, and submerged it in New York harbour, succeeding in telegraphing through it, was the first to suggest the transmission of current through an insulated wire, under water. In 1812 Baron Schilling insulated a wire with India-rubber and laying it across the Neva, succeeded in firing mines with the agency of a voltaic pile. He repeated these experiments in Germany, and afterwards in France. With regard to telephony, some space is given to a description of the effects of induction, and the means taken to neutralise this impediment are dealt with. The symbols "K.R." are explained (the mistake being made, however, of asserting that the K.R. of a looped line is double that of a single wire), and some account is given as to the construction of telephone lines and cables. Taking it as a whole, the article possesses merit. We would wish, however, to point out that with reference to the first Atlantic cable, due justice is seldom done to those Liverpool merchants, and shareholders of the Magnetic Company, who among them subscribed a far larger amount of capital than was obtained in America; without their co-operation Cyrus Field, energetic and persevering though he was, would have scarcely seen his scheme realised so soon. How is it, we would ask, that Sir Samuel Canning's name has been omitted from the list of those who were chiefly instrumental in making Transatlantic telegraphy a possibility and a success? We read of Sir James (then Captain) Anderson among the illustrious names connected with the early history of submarine telegraphy: it would seem that it is not generally known how much was due to Captain Moriarty, R.N.

The Largest Arc Lighting Station.

THE New York *Electrical World* considers the most important points in the station which is described on p. 70 of our present issue to be the following:—The feature of the St. Louis plant is the shafting room; the very large Corliss engines which are used are belted on the main line shafts, which occupy a long hall by themselves, and from which the belts rise through the ceiling to operate the dynamos. In some respects this arangement is not without its faults, but where the cost of land is high, placing practically the whole plant on a single floor is too expensive, and recourse has to be taken to methods like the one we are considering. An interesting minor point in the operation of the system is the use of oil for fuel on a large scale. This has increased the capacity of the boilers and lessened the amount of care required, so that the oil fuel is a rather successful competitor of coal, even at the low price at which the latter can be furnished. The principal point to criticise in the plan is the use of simple engines instead of compound or triple expansion machines. There are 10 great Corliss engines capable of handling an aggregate load of 8,400 arc lamps. For a plant of this magnitude it almost goes without saying at the present time that compound condensing engines are a very considerable advantage, and the more recent stations are generally being equipped with them. Much of the success of this St. Louis plant is due to the great skill with which the details have been worked out, and with which all the minor operations are conducted. A complete system of checks, testing every portion of the apparatus, and watching its performance are in regular use, and have added much to the freedom from minor difficulties which has been secured. Outside of the station the same watchfulness is exercised, and by thoroughly systematic administration of the work it has been possible to conduct it with a degree of economy that was scarcely to be anticipated, and it must be said that the colossal station is in every way a first-class working success. We cannot do better than commend our readers to the careful study of our very elaborate description of this immense lighting station.

Substance or Shadow?

AT the meeting of the shareholders of Woodhouse & Rawson United, Limited, resolutions were passed increasing the capital and authorising the directors to arrange the repayment to the predecessor company's liquidators of the amount deposited by them as a dividend guarantee fund. The terms of the deposit were that the money should be retained until July 1st, 1892, but the directors are anxious to repay it at once on terms which will be decidedly advantageous to Woodhouse and Rawson United. This statement puts the matter beyond criticism. Otherwise we should have thought the arrangement was somewhat analagous to that in which the substance is exchanged for the shadow. We are glad to find that the supply department shows large increase of orders and the manufacturing profits are expected to be larger this year. We do not doubt that the supply and manufacturing departments might be considerably extended. It is the promotion department which needs narrowing and the others would correspondingly expand. The chairman's speech does not give much promise of this, unfortunately.

A Gassy Dispute.

A LIVELY state of affairs prevails at Laeken, a small town in Belgium. Thirty years ago the municipality entered into a contract with the local gas company for the public lighting of the town. It was agreed that the price should be fixed at £1,600 per annum, the contract to exist for 55 years. Thus the agreement remains good for another 25 years, but the municipality contend that the price which was considered just when the contract was made, should now be reduced, as it is excessive when compared with other towns where only £200 per annum is paid for the same amount of light. As the gas company refuses to reduce its price, complaints regarding defective lighting, which had previously been permitted to pass unnoticed, are now numerous. In order to bring the gas company to reason, the municipality is adopting a drastic policy. For every gas jet below the contract candle-power, a fine of 2 francs is imposed; for each square of glass not properly cleaned, a fine of 5d.; a broken glass, 5d.; and for a lamp extinguished, a caution first and a fine afterwards. All these defects were formerly passed over, but now the police and the inhabitants take delight in discovering any irregularity in the lighting. If this state of affairs continues, it is expected that the town will not only get its lighting done gratuitously, but also make a profit. After this disclosure regarding gas lighting, electric light companies need not be grumbled at.

THE LARGEST ARC LIGHTING STATION IN THE WORLD.

THE report of the general manager of the Municipal Electric Lighting and Power Company of St. Louis for the month of September shows an income from the city lighting of some $10,000 and an allowance or rebate for imperfect lighting of about $80, a deduction of less than one per cent.; and this, too, in the face of a system of checks and counter-checks that appears to render it impossible for a lamp to blink twice in succession without having a report entered against it. Furthermore, the plant has not yet been in operation seven months, though during that period not a moment's time has been lost, except on one occasion, when the carelessness of an employé caused the shutting down of two engines for something less than 30 minutes.

Brought into existence under adverse circumstances, and with new conditions to be met on every side, planned and completed in the face of difficulties that appeared almost insurmountable, and within a period of time almost too short for belief, the central station plant of the Municipal Electric Lighting and Power Company, of St. Louis, stands to-day a splendid monument to the ability, foresight and indomitable will of the man whose keen, practical judgment and guidance has placed in successful operation the largest arc lighting station in the word, Mr. James I Ayer.

The operation and maintenance of this plant is so simple and economical that many of the features introduced are worthy of careful consideration by all central station men, while every reader can find much of interest in the business-like methods pursued in the management of this great enterprise that includes, in addition to the substantial station, a pole line circuit nearly 900 miles in length, supported on some 10,000 poles.

When the City Assembly, on December 29th, 1888, gave ten days' notice to the St. Louis Board of Improvements in which to advertise for 30 days in newspapers of St. Louis, New York, Philadelphia and Pittsburgh for proposals to light the city streets and public buildings with electricity, and to prepare all necessary plans and specifications for the work, it was considered simply a political move in the results of which the people had so little faith that on the day the contracts were awarded, March 9th, 1889, a wager of $1,000 was offered that they would never be closed.

Mr. Chas. Sutter received the contracts for the out-door lighting of both Northern and Southern districts of the city by the arc system, Washington Avenue being the dividing line between the districts. His bid for the Southern district was $84,780.50, and for the Northern district $81,659 per year.

One incandescent lighting contract for illuminating public buildings and alleys in the Southern district, went to the Missouri Electric Light and Power Company, at $50,525 per year; and the other incandescent lighting contract for the Northern district, went to Charles E. Brown, of the Western Electric Company of Chicago, at $33,327.80. The latter assigned his contract, almost immediately, to the Laclede Gas Company, which is carrying it out.

The original specifications called for the following lights; For lighting the streets of the Southern district, comprising the territory between Keokuk Street and Washington Avenue, 1,100 arc lamps of 2,000 C.P.; 20 arc lamps of 2,000 C.P. for the parks; 30 arc lamps of the same power for public buildings; for parks in addition, 200 incandescent lamps of 30 C.P.; for public buildings, 2,200 incandescent lamps of 16 C.P. For the Northern district, 1,000 arc lamps of 2,000 C.P. each for street lighting; 10 arc lamps of 2,000 C.P. each for the parks; 50 arc lamps of the same power for public buildings; 100 incandescent lamps of 30 C.P. for the parks, and 890 incandescent lamps of 16 C.P. for public buildings. The magnitude of the arc light contract and of the whole undertaking can be more easily appreciated when it is further stated that not one stroke of work had been done toward carrying the contract to completion when it was awarded, though but nine months remained in which to complete the work.

Mr. Sutter's first move was to secure the services of a competent superintendent, and in appointing Mr. James I Ayer to that position, on June 21st, the successful termination of his important plans was practically assured. Mr. Ayer at once notified the various supply houses of his requirements, and the visits of wire, pole, engine, belting and general supply men to the Southern Hotel in May, 1889, will long be remembered by the representatives present. Meanwhile, a piece of ground had been secured extending west along the railway tracks between Eighteenth and Twenty-first streets and the Missouri Pacific tracks. It was an admirable location, but of less size than desired, though all that could be obtained in that vicinity, and was what remained of an old stone quarry, having a high bank at one end that had to be blasted down, and a deep excavation at the other end that required filling, all of which consumed valuable time. Then the necessary foundation over the filled ground portion was secured by driving 800 piles in regular rows through 20 feet of the made ground to the solid rock, placing on top a cap of 12 × 12 timbers, and filling the space between with a layer of macadam concrete, and covering all to a depth of six inches above the capping. On this concrete the brickwork was laid in cement, 1,200,000 bricks being used for the foundations of the engines alone. All this work was necessary as more desirable ground could not be secured for a reasonable investment, and on this site the buildings stand completed to-day, and consist of the station proper, the annex and the boiler house; all substantial, fireproof structures of pressed brick, stone and iron.

The boiler house, having a frontage of 110 feet, a depth of 60 feet, and an interior height of 48 feet, stands 50 feet distant from, but connected to the station house by a viaduct supported on steel **I** girders, with concrete arches covered with granitoid cement, the top or surface of this viaduct forming the end of Nineteenth Street. The available floor space within the boiler room being but 54 × 104 feet, and as no additional ground adjoining could be secured for any price within reason, the prominent boiler makers of the country were called in to estimate on the greatest amount of boiler capacity that could be placed therein. Finally the management gave the contract to the firm of Rohan Bros., of St. Louis, stipulating for the installation of 19 of the Phil. Rohan special type of upright boilers, with a total mimimum indicated horse-power capacity of 6,500, and these boilers, or so many as are now requisite, are in daily operation. The coal used costs $1.50 per ton, delivered on the track close to the boiler house, and is shovelled into small hand cars that are then pushed along a tramway till the coal is dumped into a runway that leads directly in front of the furnace door, thus necessitating the handling of the fuel but once before being placed in the furnace. Six of the boilers have been equipped with the Standard Oil Company's fuel oil device, and the necessary oil is delivered in tanks at a cost of less than two cents. per gallon. The use of fuel oil has increased the rated capacity of the boilers about 20 per cent., and it is considered a most desirable fuel in every way, provided the price was made sufficiently low to compete with the low price at which coal can be purchased.

Rohan's special exhaust steam heaters and purifiers, and Hall's duplex pumps are in use; these with the oil pumps and filters and the steam supply and exhaust pipes are on the lower floor of the annex connecting the boiler house to the station and commonly referred to as the viaduct, the upper floor of the annex, which is about four feet above the level of the railway tracks, being used for the receiving and storing of coal, freight, &c.

The smoke stack is of quarter-inch boiler iron, double riveted, 226 feet in height, and 13 feet in diameter, the base, 32 feet in diameter, resting on a solid foundation of seven feet of concrete placed on solid rock 27 feet below the level of the railway tracks. This iron stack is said to be one of the largest in the country, and the coronet of arc lights suspended from the gallery near the top is the admiration of every lover of the beautiful, and can be distinguished for many miles when burning at night.

All steam pipes, valves, fittings, &c., leading from boilers to engines are in duplicate throughout. There are no overhead steam pipes within the station house, the pipes passing beneath the flooring. There are three main steam pipes of wrought iron, hot rivetted, with expansion joints, that are carried in hangers supported on the **I** girders of the engine room floor. The largest is 24 inches in diameter, the second 18 inches and the third 10 inches; the first two being 170 feet in length. The third, or smaller pipe, is an auxiliary feeder for daylight service, and is independently connected to three engines, thus enabling the company to operate up to 1,000 arc lights without putting a pound of steam in the main pipes. The exhaust main is 36 inches in diameter and suspended under the feed pipes. All the steam pipes are properly covered with Flegle's patent air space covering, consisting of a metallic wrapper having flanged contact edges holding the insides of the wrapper distant ½ inch from the pipes and forming an air space of 28 inches in length; each end being sealed with asbestos fireproof cement. The covering inclosing the metal forming the air space is of sheet asbestos and paper placed in layers to the depth of half an inch, the outer coating being finished in canvas and painted white, rendering it waterproof as well as a perfect insulator. The boilers and larger surfaces are surrounded with Flegle's metallic air space covering, over which is placed a 1 inch layer of asbestos cement, rendering it fireproof in every respect. As the atmosphere of the pipe tunnel is always from 30° to 60° Fahrenheit above that of the engine room, excessive condensation is well guarded against. The object attained in carrying the pipes beneath the flooring is that all overhead hangers and scaffolding is done away with; the vibration to the pipes is lessened as the ends of the **I** girders are embedded in the engine foundations; all dirt and drippings from leaks that prove so annoying in an engine room are avoided; all possible damage to belting from the escaping of steam is obviated, a matter of much importance when so large a number of cemented belts are in use; the convenience in making repairs is increased and the general appearance of the engine room enhanced by the absence of overhead piping. All condensation of steam in the pipes is trapped back to a hot well from which it is pumped to a tank on the roof and from there returned to the boilers, effecting a saving of about 50 per cent. in water consumption.

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* *Electrical World*, New York.

The station house proper is a handsome four-story, fireproof, pressed brick and stone building, with a depth of 100 feet, a height of 65 feet and a total frontage of 110 feet. The stone base is well carved and seven pilasters enrich the appearance of the front, while the windows and doors are arched. The walls range from 26 to 18 inches in thickness, the floor beams are of rolled steel, the stairways entirely of iron, while the total cost of station, annex and boiler house aggregates $200,000.

The lower or ground floor contains the engines, the second floor the line shafting and friction clutch pulleys, the third floor the dynamos and switchboard, and the fourth or top floor the store room, testing department, general repair shop, bath rooms, closets, reading rooms, library, &c., while the wire or line circuit house is on the roof. These floors are supported by round cast iron columns placed in rows about 18 feet apart, those on the main floor being 12 inches in diameter, diminishing to eight inches on the top floor.

The engine room is on the ground floor, a step above the level of the railway tracks, and is 105 feet long by 95 feet deep by 20 feet in height, with a granitoid flooring. This room is arranged to contain ten engines of the Hamilton-Corliss type, each of 600 H.P., six being now in position, and the remaining four will be added as fast as required. To each engine is assigned a load of 840 arc lights divided into a dynamo capacity of 14 60-light dynamos, or the equivalent of this duty in power or incandescent work. Thus the total capacity of the station will be 8,400 arc lights, or, allowing a reserve force of one-sixth, a standard working capacity of 7,000 arc lights, a greater working capacity than any plant now in existence.

Underneath the engine room is a large oil cellar in which the oils used are filtered upwards through water, sand and charcoal. Galvanised iron lined oil cabinets stand on every floor and contain the oiling cans and the wiping towels, no "waste" being allowed about the place. Cleanliness is preserved in the highest degree.

The second floor is equipped with 400 feet of 6-inch hammered iron shafting, ground and polished, divided into eight sections of 50 feet each and set up in four parallel lines on floor stands which are bolted to double 1-inch beams below. The bearings of the shafting are self-aligning and adjusting, and vary in length from 18 to 32 inches. Each shaft is driven by a 48-inch double leather belt running over a steel rimmed pulley 56 inches in diameter, 52-inch face. On each shaft is placed seven doubled crown friction clutch pulleys 52 inches in diameter, with 22-inch face, from which lead fourteen 10-inch belts to the floor above to drive the dynamos. Both the 112 small belts and the large 48-inch belts were furnished by the Charles Munson Belting Company, of Chicago; Charles A. Schieren & Co., of New York, and the Shultz Belting Company, of St. Louis. The clutch mechanism is operated from the dynamo floor by a simple lever device which lies in a cavity in the floor made to receive it when not in use. Each engine belt has a patented steel rim tightener pulley, 36 inches in diameter, with a 52-inch face, which is operated from the shafting floor to tighten or loosen the belt. All the castings are exceptionally smooth and well made, all collars and couplings being well turned and polished, giving the whole a finished appearance. The boxes are lined with babbitt metal, reamed and bored, with deep oil grooves running backward and forward that insure perfect lubrication. The necessary oil is fed to each bearing by a system of pipes and carried thence by drain pipes to the oil filter in the basement, from which it is pumped to the fourth story to be used again. All the transmitting machinery on this floor was made and set up in place in a most thorough and workmanlike manner by the Falls Rivet and Machine Company, of Cuyahoga Falls, O., and the best evidence of its satisfactory character is that, while only one man is required to care for all of it during operating hours, not one minute's time has been lost from any mechanical defect or cause since the plant was started.

The dynamo room is on the third floor, and extends the full length and width of the building. Fifty-three 60-light improved Wood dynamos, manufactured by the Fort Wayne Electric Company, occupy a little less than half of the available space for dynamos. The conductors from the dynamos are carried through the floor in glass tubes to a series of racks suspended underneath the floor of the dynamo room and above the transmitting machinery, wherein they are supported on glass tubes till passed upward through the floor in a casing of glass and terminate in a table immediately in front of the switchboard, where they are connected to duplex sockets. The switchboard is a model of its kind, designed from plans made by Mr. McGrath, of the Fort Wayne Electric Company, and modified or added to, to render it more complete. The switchboard proper is furnished with duplex terminals to all circuits in each of seven different sections, and is so arranged that within a space of about seven feet square, which constitutes a section, connections can be made with any other circuit. The top of the switchboard is surmounted with a cornice which contains 70 current indicators made by the Lockwood Instrument Company of Detroit, and so arranged as to indicate when the current is flowing through a circuit and in what direction. In one section, at one end of the switchboard, ammeter sockets are being placed in a position that will enable the dynamo tender to rapidly plug an ammeter in any circuit.

Owing to the systematic methods employed, the entire lighting of the city is started practically on the instant, it requiring never more than 120 seconds to have every lamp burning. This rapidity of lighting is greatly facilitated by the perfect working of Mr. Wood's automatic regulator. Steam is turned on about 15 minutes earlier, and thus an important saving is effected for the burning of 3,000 or more lamps for half an hour too long or not long enough means an output of fuel the value of which in the agregate amounts to a large sum, or to a heavy rebate.

Since the machinery was placed in operation, Mr. Ayer has been regularly operating 62 lights over a circuit of 19½ miles, and the brilliancy of the lights and the normal ampère current maintained. This speaks well for the line insulation and connections as well as for the dynamos.

On the dynamo floor is located the fire alarm gong, directly connected to the headquarters of the City Fire Alarm Department, and a private telephone connected with the Police and Fire Department. Thus every alarm is repeated in the dynamo room, and on a second alarm being turned, in an inspector hurries to the relief of the firemen. On this floor, where all the trimmers and linemen have easy access, is placed an immense map of the city, all lamps being indicated by tacks, and the various circuits by different coloured threads. By this means any circuit can be readily traced, and every lamp located. Station managers who have been compelled to keep unsatisfactory employés simply because they were acquainted with the circuits and the location of the lamps will appreciate the value of such a map. There is a small office on this floor, and a public telephone, also a private telephone connected to the down town offices.

On the fourth or top floor, where the wires come in from the wire house on the roof and pass to a rack holding the Thomson-Houston lightning arrestors in parallel rows, is placed a testing board arranged for connections with Wheatstone bridge, ammeters, and voltmeters to all circuits. The station is supplied with Weston's direct reading voltmeters, reading from one-tenth of a volt to 150 volts, with multipliers for same, giving a reading to 4,500 volts; Weston's and Wood's ammeter's and Greeley's high grade galvanometer's are also at hand. All circuits are tested at regular intervals four times each day, and the voltage is daily measured across the terminals of each circuit, a record of each test being entered on the proper blank, headed, "Record of circuit tests for the 24 hours ending ....," which blank also shows the length of each circuit, and the number of lamps in that circuit. Thus the highest efficiency is obtained, as any increase in the normal resistance is at once indicated; the leakage to ground being also measured while the circuits are in operation and the location of the leak detected. Each and every circuit is connected with the ammeters several times during the night, so that any change in the quantity of current is detected and remedied at once.

The Repair Department is also on this floor and contains lathes and other machinery, the necessary tools, and competent workmen. Thus, if a lamp needs overhauling it is brought in and a card bearing the following heading is attached, and there remains until the lamp is again placed in service: "Record of lamp repairs—Lamp No. .... returned .... 1890, by .... from .... trouble......... Material used................ $......... Hours labour............ $......... Testing......... $......... Total $......... Lamp run .... hours .... 1890; volts ....; volts......: volts ....; lamp run ...... hours ...... 1890; volts......; volts ......; volts ......; ready for service .... 1890. Entered L. R. by .... Entered daily R. by .... When all mechanical repairs have been made on a lamp it is given a twelve hour run on the test rack, and the length of the arc determined by the use of the voltmeter only, two standard Weston ammeters being used constantly to insure a normal ampére current at all times during the test.

In caring for the lamps 40 trimmers are employed, each being furnished with a two wheeled cart and the necessary harness; but each trimmer furnishes, feeds, and shoes his own horse. A blacksmith shop is maintained by the company, and there the trimmer can have his horse shod at an expense of $1, if he so desires, the usual rate being $1.50. The 28 trimmers employed on the city circuits are under the direction of the chief inspector, as are also the five deputy inspectors and the two lamp changers. Each of the city trimmers are now daily cleaning 63 lamps on a 15-mile circuit and a 20-mile drive, and are gradually working up to an average of 70 lamps. Before starting on his round each trimmer is supplied with the required number of carbons, with one globe and the necessary clean towels, and on completion of his day's work he fills in a blank form reading as follows: "Trimmer's daily report"—Trimmer..........., District No.........., ...1890. Number of lamps........., S........., D.........; total......... Number of carbons received, 12 inch..........., 7 inch...........; number of carbons used, 12 inch..........., 7 inch...........; number of carbons in box, 12 inch........., 7 inch......... Globes replaced: Clear ...., one-half ground........., opal......... Lamp towels received........., returned........., in box......... (State condition of lines, lamps, poles, &c., in your district, and changes or repairs made by you this day.)

It is not only necessary for the trimmer to make out this daily report, but he must return a carbon point for every new carbon issued, and return a soiled towel before a clean one is given, all shortages being charged to the trimmer and deducted from his pay. Towels free from lint are used on all the globes, and "waste" is not tolerated about the building. (In this connection it is worthy of note that the ends of all plain carbons are returned to the factory, where they are ground up and made over again; and all carbon boxes are sold to local wholesale hardware dealers at 10 cents each.) That the above method is satisfactory to the trimmers as well as to the company is clearly shown by the industrious manner in which they perform their duties, the excellent class of men secured and the large number of applicants for these positions. Then to encourage the men to improve on their work as shown in their daily record, and in that of the inspector, a comparative monthly record is kept that shows at a glance whether the man's service is improving or not, and on the fifth of each month a letter is sent to each trimmer commending him for noted improvement or mildly checking for apparent neglect. That these letters prove beneficial may be easily seen from the records which show that during the first month 185 globes were reported broken out of a total of 1,650 lamps; the number of lamps have been steadily increasing while the total number of globes reported broken each month has decreased respectively 185, 104, 57, 45 and so on down till the breakage to-day is less than 2 per cent., an excellent condition that has been brought about entirely by careful systematic checking. The advantages secured in using the cart in place of putting the man on horseback are manifold and obvious. A long rubber coat covering the trimmer from head to heels is furnished by the company and carried in a special compartment of the cart. Covered with this coat in rainy weather the trimmer drives along, standing on the foot-board of his cart protected from moisture in every way; the carbons are kept dry and there is always an abundance of dry towels with which to clean globes. Quite naturally the man feels that he is being well taken care of, and puts forth his best efforts in the interest of the company.

One of the general accounts is headed, "Lamps and Trimmers," and is made up from details entered on the lamp maintenance monthly sheet, which bears the following headings for entries opposite each day of the month: Date; number of men; cost of labour; single lamps; lamps repaired; number; cost; one-half carbons; seven-sixteenths carbons; total carbons; clear globes; one-half ground globes; cost of globes; opal globes; cost; cost of towels; stable expense; total cost of lamp maintenance. That sheet is prepared from the "Daily Report of Trimmers" (form 23), which reads: Trimmer (Nos. 1 to 60) total number of lamps; lamps trimmed; single; double; number of carbons used; one-half inch; seven-sixteenths inch; number of globes replaced; clear; one-half ground; opal; towels; labour time; cost; remarks.

The chief inspector has charge of the day inspector, the four night inspectors, the two lamp changers and the twenty-eight trimmers, employed on the city circuits. Special two-wheeled carts are furnished to each, the inspectors having strongly built but light carts made especially for rapid travelling and having a compartment under the seat sufficiently large to contain 150 feet of line wire, a cut-out or two, insulators, brackets, pliers, and whatever is necessary to rapidly construct a loop line. Each inspector furnishes an excellent horse that can be depended on, and when a telephone message comes in that a heavy wind has blown a tree across the lines, or a second alarm is received from the fire department, the inspector drives with the utmost haste to the point of trouble, and takes such action as may appear necessary to keep as many as possible of the lights burning or to repair the line. During a recent fire prompt action on the part of an inspector prevented a loss of $145 in rebates that would have been deducted had not his work kept every lamp in circuit. This method of looking after troubles at night is so systematised that only in two instances has a circuit remained open for over thirty minutes, a rare and remarkable record.

The "Inspectors' Daily report" reads: From ...... P.M. to ...... A. M. ......, 1890. Description of trouble ......; material used ......, $...... Reported troubles by telephone at ...... P.M., ... P.M., ... P.M., ... A. M., ... A M., ... A.M. Total hours locating trouble .... Total hours removing trouble ...... Total hours on patrol .... Total hours at station .... Number of troubles found by me......... Number of troubles reported to me .... Number of troubles cleared ....

While form 6 reads: This certifies that my lights were inspected at ...... P.M., also at ...... A.M., and the service has been satisfactory since last report, except as noted below...

These reports and that of the chief inspector are incorporated into a "Daily Report of Inspectors" (form 39), reading as follows: Number, on duty, from .... to ....; number hours ......; hours' patrol ......; hours on trouble ......; number troubles ......; found by him ......; reported to him ......; total ......; total removed ......;

total fire calls ...... ; cost ...... ; repair ...... ; material ...... ; stable ...... ; H., C. & H. ...... ; amount ...... ; rate ...... ; wages ...... ; remarks ......

The conditions under which this work was planned and carried through were so different from those usually presented; that new methods and new forms of material had to be created. For instance, guy wire would not be tolerated on the main streets, so a simple, inexpensive form of truss was devised for maintaining the poles at street intersections. As all arc lamps had to be suspended 35 feet above the roadway clear of the bottom of the lamp, and not more than 800 feet apart, the Board of Public Improvements in the contract specified "that lamps shall be suspended over centre of street," and in compliance the simplest device known, consisting of $\frac{5}{16}$-inch steel suspension cable attached by means of eye bolts to poles of proper height was selected. To this cable two Fletcher sleet proof pulleys were firmly attached, one being placed in the centre and the other close to the pole supporting the windlass box.

These windlass boxes are made so as to be used on either side of the pole and always permit the drum to rotate inwardly or toward the pole, thus drawing the raising cable, which is one-quarter inch charcoal iron wire of 32 strands, close to the pole. Each windlass door is fitted with a Yale lock, so that when the lamp is once left in position it cannot be disturbed without cutting the wire rope, and to do that it will be necessary to climb the pole, as the boxes are placed about 6 feet above the sidewalk.

All the lamps are of the Wood type of double carbon lamp and are protected by a deep conical hood complete with hanger board and cut-out. The cross support for wires over lamp hood is provided with double petticoat pony glass insulators.

In constructing the circuits and the entire plant they were built for the future, anticipating the rapid increase that has already set in. At the present time there are 176 wires or 88 round circuits that pass out or return to the building through glass tubes and hollow fire-brick. These wires pass out from the wire house on the roof of the station, and thence to the first pole in regular order, commencing at the top cross arm, so that a lineman, being told the number of a circuit, can easily trace or pick it up at any designated point. Simplex wire has been used throughout the entire installation, over 900 miles being now employed. At the time the contract was placed for wire Mr. Ayer was besieged by the representatives of the different manufacturers of insulated wire, and strong pressure was brought to bear to induce him to purchase a low priced insulation by representations to Mr. Sutter that "the cheapest was just as good." But Mr. Ayer took a firm stand at a time when high grade insulation for aerial wires was little used. Within a few months he had the satisfaction of seeing his position supported by newspaper argument, and, what is more convincing, large orders for similar insulation were placed by parties well advised who were constructing other large plants and who had previously criticised his action.

Over 10,000 select white cedar poles have been used, ranging in length from 40 to 65 feet, the majority of which were "gained" for five cross arms, and all were neatly shaved. The cross arms used are four, six and eight pin, and are five, seven and nine feet in length respectively, thus allowing ample room for a lineman to work between the wires, and every cross arm has been braced.

Among the special circuit devices is a cross circuit break arm having a total spread of 15 inches, 10 inches from one pin to centre of core, leaving only five inches from the remaining pin, and which are used where it has been necessary to cross from one end of the arm to the opposite end and safely clear all other wires and the pole and not interfere with the climber.

The wall brackets used have a strong base, allowing fully two and a half inches between the screw holes; the sign and roof bracket is eight inches in length. with an oval base having four screw holes. Then there are lateral, right and left hand, cornice, side and off-set brackets. All these are made of the best quality soft gray iron, cast in star shape form, and are exceedingly light but of ample strength, and of improved form. When stringing the wire one man in each gang was employed solely in making and soldering all joints, and was previously thoroughly instructed in the art preservative of current; thus there is every reason to believe that that portion of the work was well done throughout. Three mottoes were always kept before the men: "When you require insulation you cannot get it too good." "When connections are being made you cannot make them too strong." "Avoid complications; the simplest is generally the most efficient."

Mr. Ayer's systematic method of keeping track of all the minute details that enter into the operation and maintenance of a plant of this magnitude is worthy of more than a passing notice, for there are many features that could well be tested in some of the smaller plants that have proved hardly self-sustaining simply through an absence of all watchfulness over the minutiæ, from the lack of which spring the small leaks that increase in volume so rapidly. Blank forms of about the size and color of a telegraph blank are used, on which the men record the work they have done each day, with all details thereto pertaining. From these sub-reports there is prepared in the main office a "condensed daily report" covering the twenty-four hours, that clearly shows in dollars and cents the daily out-put and the daily earnings, as follows: Dynamo room, engine and boiler, lamps and trimmers, line work, inspection, store room, office, salaries, taxes and insurance, stable; total cost. Earnings: City, commercial, extra service, motor earnings, sundry earnings, stable; total amounts.

These sub-forms are also used in daily filling in the condensed monthly report, that shows at a glance both the hours of service and the amount and money value of all material consumed. For instance, under the account heading of "engine-room" the following sub-heads appear: Date, engines in service, hours in service, employés, wages, towels, gallons oils, engine, cylinder, grease, packing, sundry supplies; repairs, labour, material; construction, labour, material.

"Engine-room" and "boiler-house" appear on one sheet, 16 × 20, properly ruled, and by turning back to these various sheets the operating expenses of any day or any month, for any department, or for the entire plant, can easily be traced.

In keeping the general accounts the disbursements are charged under one of the 10 headings, as follows:—Engine and boiler, dynamo room, lamps and trimmers, line work, inspection, store room, office, salaries, taxes and insurance, while the earnings appear under the headings:—City, commercial, extra service, motor earnings, sundry earnings, stable.

A recent feature of the commercial service is the placing of arc lights along Broadway at a distance apart of but 40 feet, and suspending same from iron supports projecting from the front of buildings. The price paid for these lights is 1 cent per front foot per night. Thus they cost a merchant from 20 cents to 40 cents per lamp per night, depending on the width of his store, and their introduction has resulted in increasing the number of pedestrians on Broadway many fold, to the financial benefit of the merchants.

August 1st, 1890, by purchase this company acquired possession of the St. Louis Illuminating Company, which comprised the Thomson-Houston plant in St. Louis and East St. Louis, the Excelsior, the Western Electric and the Brush plants in St. Louis, all of which had a combined capacity of 1,500 arc lights; also the Heisler incandescent lighting plant with its 5,000 30-candle-power lamps. Since that date the Thomson-Houston plant and the Brush have been transferred to the new station and the old stations closed, and as soon as a sufficient number of Wood dynamos are received to carry the increased load the other stations will be abandoned, thus concentrating all the arc lighting under one roof, and before January 1st, 1891, more than 3,500 arc lights will be controlled from this one station.

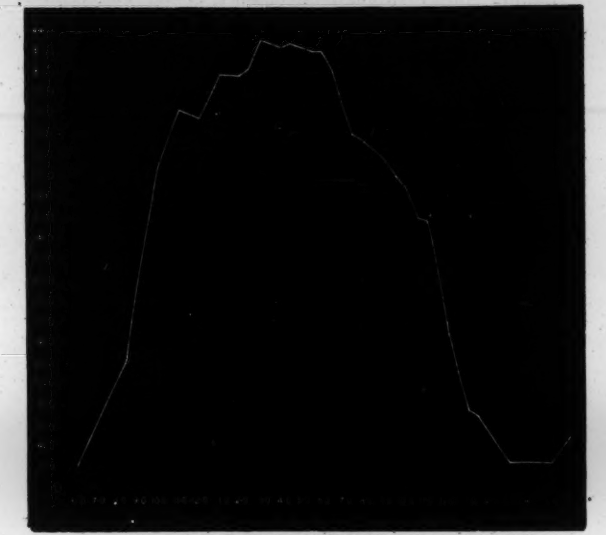
The work of dismantling these old stations and disposing of the material to the best advantage was no light task in itself. Then, in addition, Mr. Ayer replaced all the old circuits with Simplex wire strung on new poles, and forming part of his extensive but simple system. As all this old wire is in the usual condition presented by wire strung in past years when competing companies were struggling for business, little else can be done with it than to saturate the insulation in Simplex paint, and cut into small lengths for tie wire, or use short lengths for temporary work. Since August 1st, 600 additional lights have been ordered by the city officials, requiring a construction force of about 160 men.

The original officers of the company were Julius Walsh, president; Charles Sutter, vice-president; Mortimer Taylor, secretary and treasurer; James I. Ayer, general manager.

The present officers are : James Campbell, president ; J. G. Kelley, secretary and treasurer ; James I. Ayer, general manager. Mr Ayer has the following chiefs of departments : George Clifford, chief engineer ; P. I. Parker, chief of dynamo department ; C. W. Heeg, chief of line department ; J. D. Culls, chief inspector.

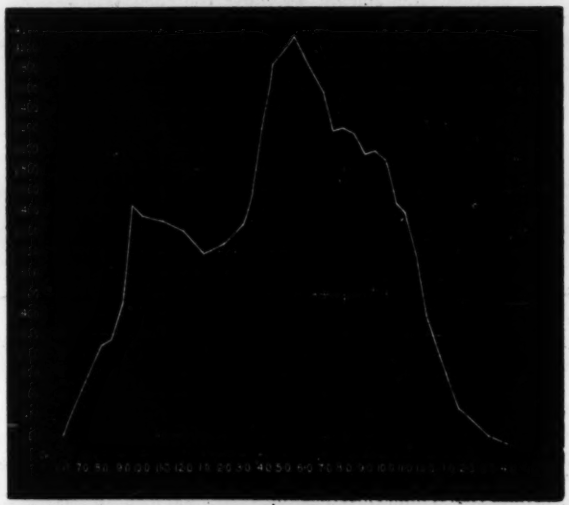
THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

THIS company, as was to be expected from the nature of the district supplied, has done exceptionally good work during the past year. The number of lamps wired on the circuits



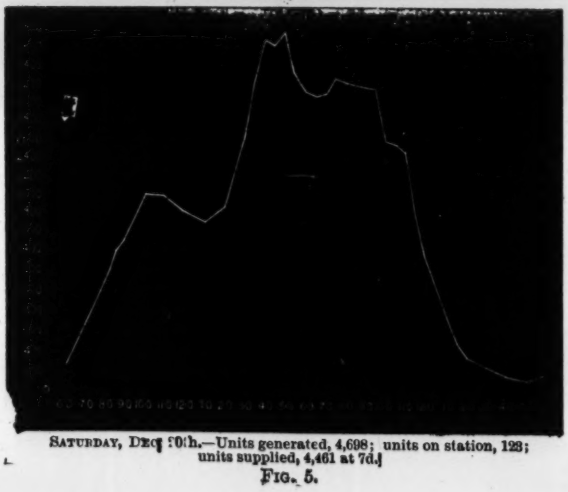
RIDAY, JAN. 2nd.—Units generated, 6,285 ; units on station, 127 ; units supplied, 6,004 at 7d.

FIG. 1.



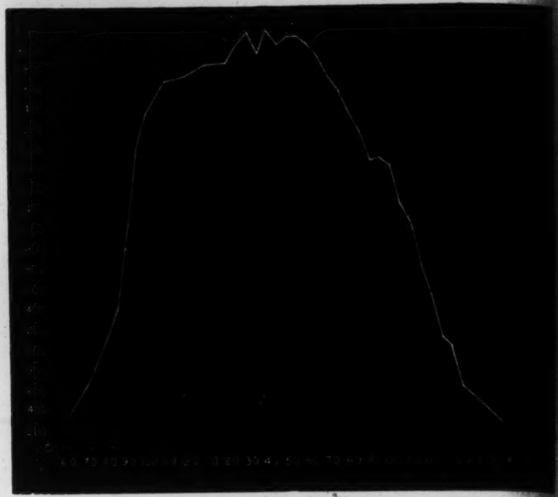
MONDAY, DEC. 29th.—Units generated, 4,871 units on station, 122 units supplied, 4,630 at 7d.

FIG, 2.



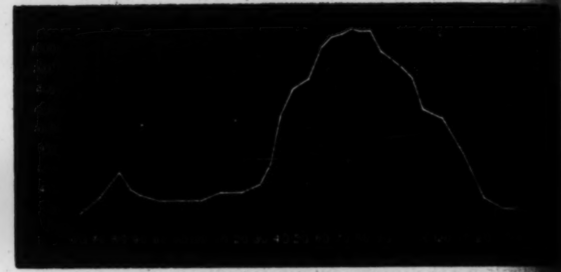
SATURDAY, DEC. 20th.—Units generated, 4,698 ; units on station, 123 ; units supplied, 4,461 at 7d.

FIG. 5.



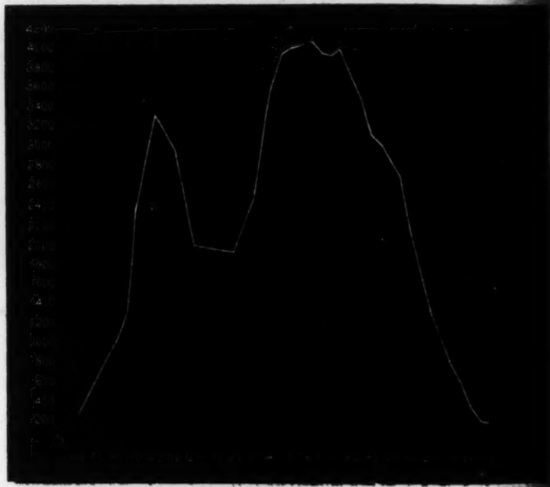
MONDAY, DEC. 22nd.—Units generated, 6,177 ; units on station, 112 ; units supplied, 5,913 at 7d.

FIG. 3.



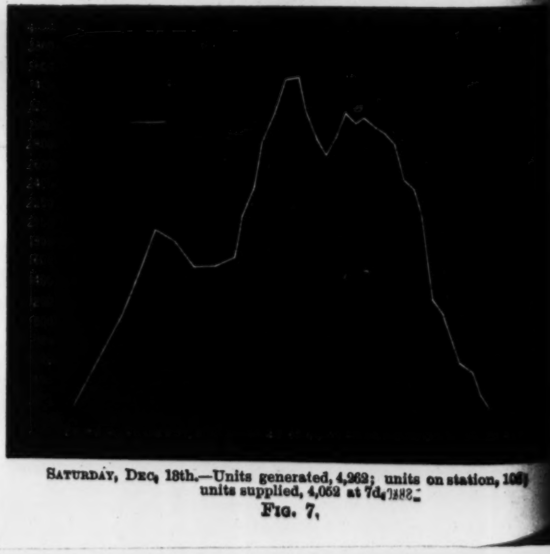
SUNDAY, DEC. 21st.—Units generated, 2,019 ; units on station, 94 ; units supplied, 1,877 at 7d.

FIG. 4.



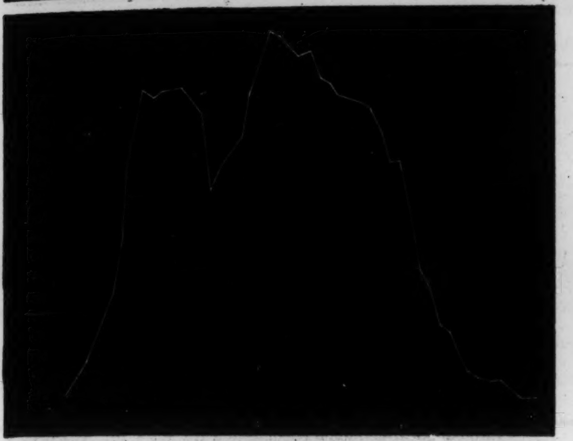
THURSDAY, DEC, 18th.—Units generated, 5,270 ; units on station, 119, units supplied, 5,022 at 7d.

FIG. 6.



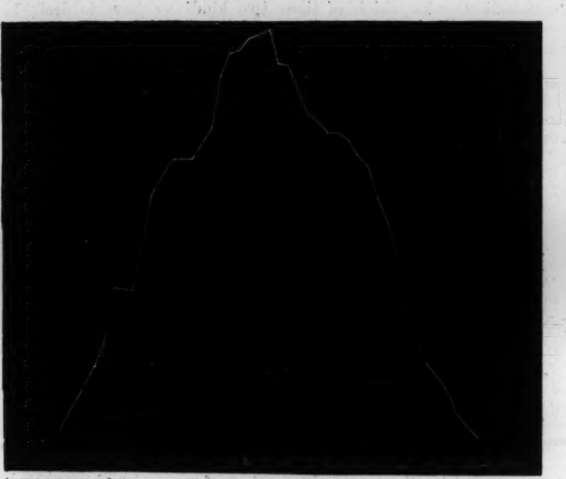
SATURDAY, DEC, 13th.—Units generated, 4,262 ; units on station, 10 units supplied, 4,052 at 7d.

FIG. 7,



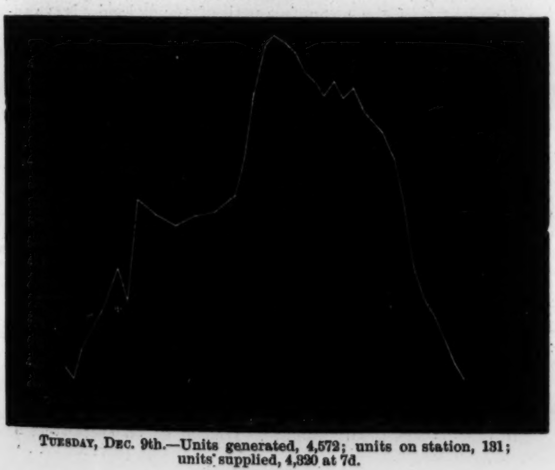
THURSDAY, DEC. 11th.—Units generated, 5,478; units on station, 180; units supplied, 5,210 at 7d.

FIG. 8.



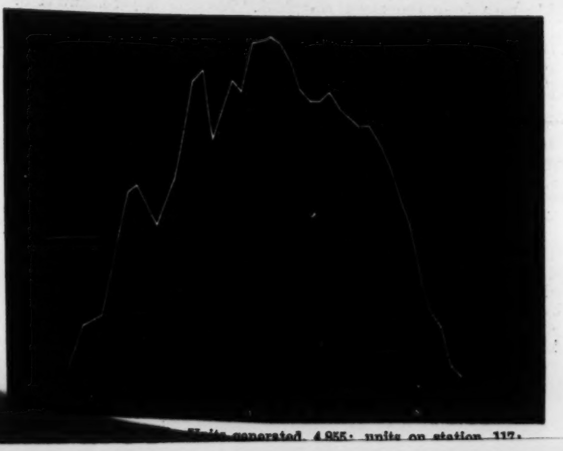
WEDNESDAY, DEC. 10th.—Units generated, 5,325; units on station, 108; units supplied, 5,087 at 7d.

FIG. 9.

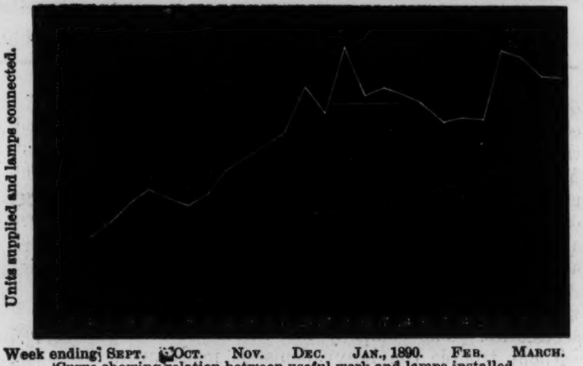


TUESDAY, DEC. 9th.—Units generated, 4,572; units on station, 181; units supplied, 4,320 at 7d.

FIG. 10.



Units generated, 4,855; units on station, 117;



Curve showing relation between useful work and lamps installed, September, 1889, to January, 1891.

FIG. 12.

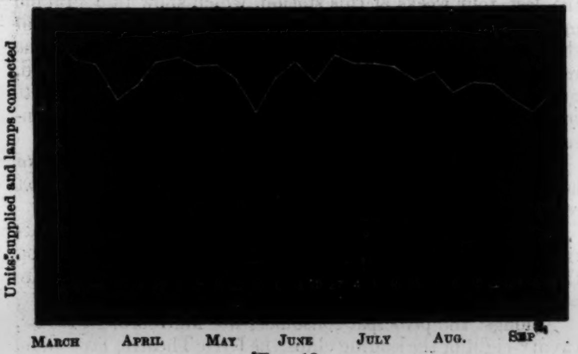
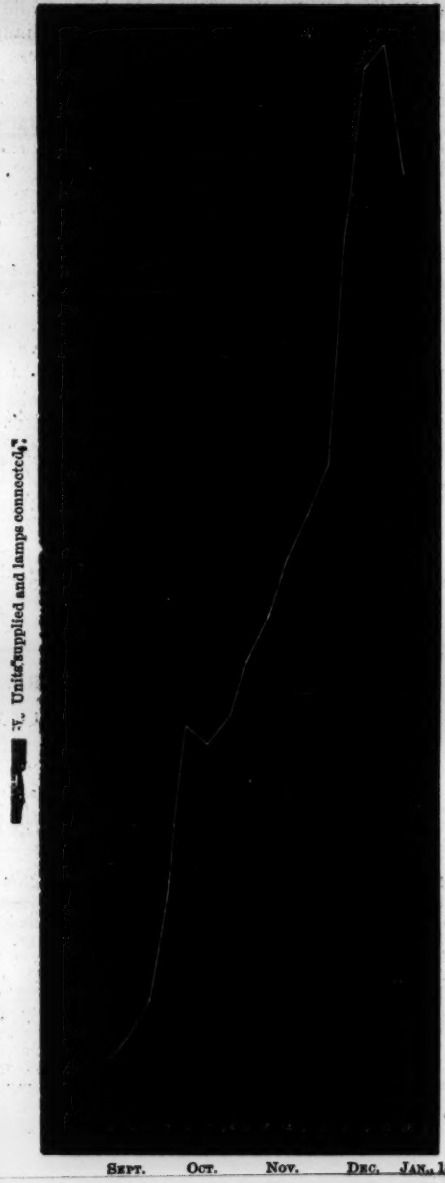


FIG. 13.



on December 31st last, amounted to a total of 13,354 in equivalents of 16 candle-power. To deal with this demand the company has at present, in the Central Station at Mason's Yard, five Davey-Paxman boilers, each capable of generating steam for two Willans and Robinson I.I. engines of 210 indicated horse power, and to these engines are coupled a series of dynamos by Siemens and Latimer Clark, Muirhead and Co., giving a total output of 10,000 ampères, by 110 volts. A sixth boiler and twelfth dynamo will shortly be added. The whole of the plant is in complete working order with all accessories. The company was therefore enabled to supply without trouble the heavy demands made upon it by the recent severe fogs..

We publish a complete series of load curves taken during the last four weeks at this station, which show in a graphic manner the amount of current sent out. The ordinates of the curves represent total ampères at any given time, the results of each day's working being given in units generated, units used for lighting the station buildings, and units supplied to consumers. The whole of the supply to the consumers is by meter.

The other curve gives a weekly record of the number of lamps wired and the number of units sold, the ordinates representing both units sold and 16 C.P. equivalents.

The supply from this company has given general satisfaction, and a large number of orders are in hand, including the Reform Club with 500 lights, and the St. James's Theatre with 300 lights.

Amongst the principal consumers are Marlborough House, twenty-eight of the leading clubs, the Lyric Theatre, Trocadero, St. James's Hall, Moore & Burgess, Egyptian Hall, Café Royal, St. James's Restaurant, Burlington Arcade (both public and private lighting), Junior Army and Navy Stores, and a number of shops and smaller consumers. To meet the increasing demand, the company intends at once to erect a second station, which will be coupled up by trunk mains to the present one in Mason's Yard. This will be at work before the autumn.

The results for the last quarter are as follows, the station being reckoned amongst the consumers :—

Units generated	267,443
Used on station	8,012
Sold to consumers	252,945
Efficiency of supply $\frac{260,957}{267,443}$ =	97·5 per cent.
Coal consumption	895 tons.
Coal per unit generated ...	7·5 lbs.
Coal per unit sold	7·7 lbs.

It has been found that the cost of the 260,957 units sold from this station during last quarter, including all engine room expenses, viz. :—Coal, cartage of coal and ashes, water, oils and waste, petty stores, labour and superintendence, comes out at 1·8 pence per unit.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers. Thursday, January 15th, 1891.

ADDRESS OF THE PRESIDENT, WILLIAM CROOKES, F.R.S.

ELECTRICITY *IN TRANSITU*: FROM PLENUM TO VACUUM.

INTRODUCTION.

WHILST steadily bearing in mind that I have the honour to address a society, not only of physicists, but of electrical engineers, I shall not, I hope, be out of order in venturing to call your attention to a purely abstract phase of electrical science. Numberless instances show that pure research is the abundant source from which spring endless streams of practical applications. We all know how speculative enquiry into the influence of electricity on the nervous systems of animals led to the knowledge of current electricity, and ultimately to the priceless possession of the telegraph and the telephone. The abstract study of certain microscopic forms of parasitic vegetable life has enabled us to give to fermented solutions of sugar the exact flavour and aroma of the most highly prized wines, and probably, ere long, will put us in a position to increase at will the fertility of the soil. In a different direction the same class of abstract researches applied to medical science has brought us within measurable distance of the final conquest over a large class of diseases hitherto incurable; and without egotism I may, perhaps, be allowed to say that my own researches into high vacua to some extent have contributed to the present degree of perfection of the incandescence lamp. Surely, therefore, whilst eagerly reaping and storing the harvest of practical benefits, we must not neglect to scatter more seed for future results, perchance not less wonderful and valuable.

In another respect I deviate to some extent from the course taken by many of my predecessors. I am about to treat electricity, not so much as an end in itself, but rather as a tool, by whose judicious use we may gain some addition to our scanty knowledge of the atoms and molecules of matter, and of the forms of energy which, by their mutual reactions, constitute the universe as it is manifest to our five senses.

I will endeavour to explain what I mean by characterising electricity as a tool. When working as a chemist in the laboratory, I find the induction spark often of great service in discriminating one element from another, also in indicating the presence of hitherto unknown elements in other bodies in quantity far too minute to be recognisable by any other means. In this way, chemists have discovered thallium, gallium, germanium, and numerous other elements. On the other hand, when examining electrical reactions in high vacua, various rare chemical elements become in turn tests for recognising the intensity and character of electric energy. Electricity, positive and negative effect respectively different movements and luminosities. Hence the behaviour of the substances upon which electricity acts may indicate with which of these two kinds we have to deal. In other physical researches, both electricity and chemistry come into play simply as means of exploration.

In submitting to you certain researches in which electricity is used as a tool, or as a means of bringing within scope of our senses phenomena that otherwise would be unrevealed, I must for a moment recall to your minds the now generally-accepted theory of the constitution of matter.

KINETIC THEORY OF GASES.

Matter, at its ultimate degree of extension, is conjectured to be not continuous, but granular. Maxwell illustrates this view as follows:— To a railway contractor driving a tunnel through a gravel-hill, the gravel may be viewed as a continuous substance. To a worm, wriggling through gravel, it makes all the difference whether the creature pushes against a piece of gravel or directs its course between the interstices. To the worm, therefore, gravel seems by no means homogeneous and continuous.

With speculations as to the constitution of liquid and solid matter I need not trouble you, but will proceed at once to the third or gaseous state of matter.

The kinetic theory of gases teaches that the constituent molecules dart in every possible direction with great but continually varying velocities, coming almost ceaselessly in mutual collision with each other.* The distance each molecule traverses without hitting another molecule is known as its *free path*; the average distance traversed without collision by the whole number of molecules of a gas at any given pressure and temperature is called the *mean free path*. The molecules exert pressure in all directions, and are only restrained by gravitation from dissipating themselves into space. In ordinary gases, the length of the mean free path of the molecules is exceedingly small compared with the dimensions of the vessel, and the properties we then observe are such as constitute the ordinary gaseous state of matter, which depend upon constant collisions. But if we greatly reduce the number of molecules in a given extent of space the free path of the molecules under electric impulse is so long that the number of their mutual collisions in any given time in comparison with the number of times they fail to collide may be disregarded. Hence, the average molecule can carry out its own motions without interference. When the mean free path becomes comparable to the dimensions of the containing vessel, the attributes which constitute gaseity shrink to a minimum, the matter attains the ultra-gaseous or "radiant" state, and we arrive at a condition where molecular motions under electrical impulse can easily be studied.

The mean free path of the molecules of a gas increases so rapidly with progressive exhaustion, that whilst that of the molecules of air at the ordinary pressure is only $\frac{1}{10000}$th of a millimetre, at an exhaustion of 100,,000,000th of an atmosphere—a point (which, with present appliances, is easy to attain) corresponding to the rarefaction of the air 90 miles above the earth's surface—the mean free path will be about 30 feet; whilst at 200 miles above the earth it will be 10,000,000 miles, and millions of miles out in the depths of space it will become practically infinite. I could go on speculating in spite of Aristotle, who said :—"Beyond the universe there are neither space, nor vacuum, nor time."

In discussing the motions of molecules we have to distinguish the *free* path from the *mean free path*. Nothing is yet known of the *absolute* length of the free path nor of the *absolute* velocity of a molecule. For anything we can prove to the contrary, these values may vary almost from zero to infinity. We can deal only with the *mean* free path and the *mean* velocity.

---

* I speak of "collisions," as these are the generally-accepted substrata of the kinetic theory. But Prof. Silvanus P. Thompson reminds me that Boltzmann some years ago proposed a modification of the kinetic theory which to me seems a vast improvement on the somewhat bald notion of molecular collisions. According to Boltzmann's view, in a so-called "collision" the molecules do not actually bump against one another, but merely fly round in two interlocking hyperbolic paths. The effect, for all external purposes will be the same as if they collided, because of the extreme minuteness of the curved parts of the paths. The gain in thus regarding the matter is that such hyperbolic paths are quite consistent with obedience to the ordinary laws of gravitational attraction; whereas the collision theory needs for its explanation that when molecules come very near together they should exhibit a repulsion varying inversely as the fifth power of the distance between them.

P = 75 mm.

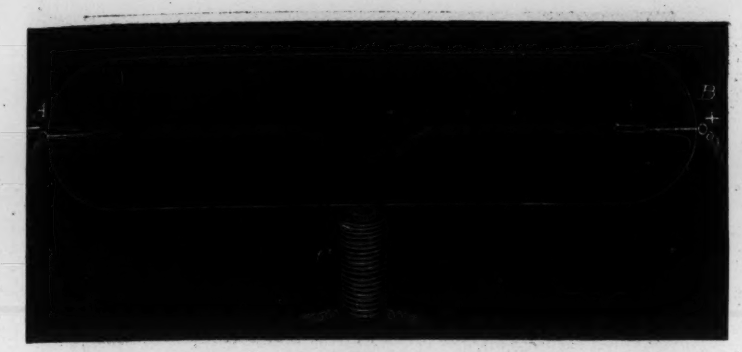


FIG. 1.

P = 0·1 mm. = 131·5 M.

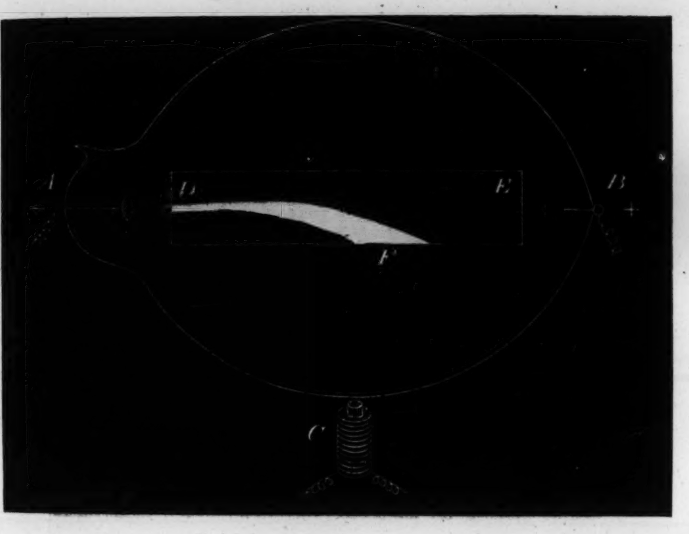


FIG. 2.

P = 2·0 mm. = 2,630·0 M.

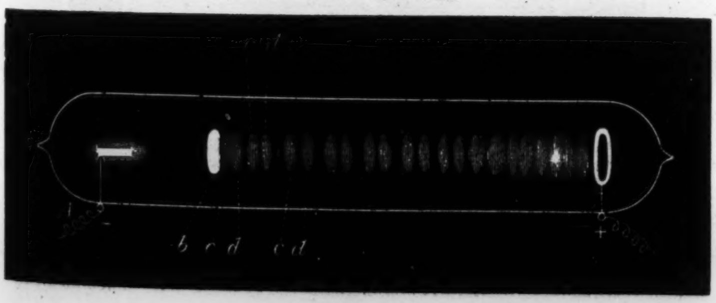


FIG. 3.

P = 2·0 mm. = 2,633·0 M.

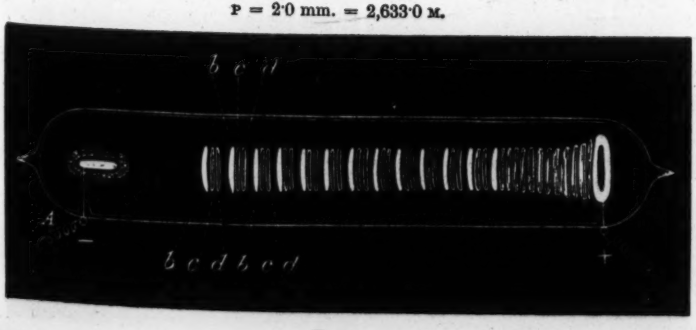


FIG. 4.

THE VACUUM PUMP.

As most of the experiments I put before you to-night are connected with high vacua, it is not out of place to refer to the pump by means of which these tubes are exhausted. Much has been said lately in recommendation of the Geissler pump and its many improvements, but I am strongly in favour of the Sprengel, as with it I have obtained greater exhaustion than with any other. I should like to point out that the action does not stop when we cease to see air specks passing down the tubes, but continues long after this point has been passed. Neither is the non-conducting vacuum, so easily obtained by the Sprengel pump, due in any way to the presence of mercury vapour, since non-conduction can be obtained just as rapidly when special precautions have been taken to keep mercury vapour out of the tubes.

One of the great advantages of the Sprengel pump over all others lies in the fact that its internal capacity need not exceed a few cubic centimetres, and there is, therefore, much less wall surface for gases to condense upon. I have brought the very latest modification of this form of pump here to-night, and you will have an opportunity of seeing it in action and of measuring with the McLeod gauge the rarefaction it produces.*

THE PASSAGE OF ELECTRICITY THROUGH RAREFIED GAS.

The various phenomena presented when an induction spark is made to pass through a gas at different degrees of exhaustion point to a modified condition of the matter at the highest exhaustions. Here are three exactly similar bulbs, the electrodes being aluminium balls, and the internal pressures being respectively 75 mm., 2 mm., and 0·1 mm.

If I pass the induction current in succession through the bulbs, you will perceive in each case very different luminous phenomena. Here is a slightly exhausted tube (fig. 1), like the first in the series just exhibited (75 mm.), the induction spark passes from one end to the other A, B, and the luminous discharge is seen as a line of light, acting as a flexible conductor. Under the tube I have an electro-magnet, C, and on making contact the line of light dips in the centre down to the poles of the magnet, and then rising again proceeds in a straight line. On reversing the current the line of light curves upwards. Notice that the action of the magnet in this case is only local.

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* My measurements of high vacua have al been taken with the beautiful little gauge devised by Prof. McLeod. Unmerited discredit has recently been cast upon this gauge, the principal fault alleged being its inability to distinguish between the tension of the permanent gas and that of the mercury vapour present Now it is evident that, under ordinary circumstances, the tension of mercury vapour may be disregarded, as it will be the same on both sides of the gauge; and it will be only in cases where no mercury is present on one side of the gauge that a slight error is introduced. It is, however, very difficult to devise and successfully experiment with apparatus in which a trace of mercury vapour shall not enter, and it is not likely that an experimentalist who would be working with such mercury-free apparatus would attempt to use the gauge without remembering that in this special case the indications would be incorrect. To use the McLeod gauge requires much patience and some amount of experience, but I have always found it trustworthy to register exhaustions far beyond the millioneth of an atmosphere. I can adduce circumstantial evidence of the accuracy of its readings at these high vacua. In the year 1881 I read a paper before the Royal Society on "The Viscosity of Gases at High Exhaustions" (*Phil. Trans.*, 1881, p. 387), and illustrated my results by three large diagrams, on which I plotted the experimental results obtained at rarefactions up to the 0·02 millioneth of an atmosphere, giving curves comparing the decrease in viscosity with that of the repulsion resulting from radiation, at the different pressures. Now these curves, in the case of air, for instance, are perfectly regular and uniform in their falling off, and it is evident that this could not have been the case unless the abscissæ representing viscosity and the ordinates representing pressure were equally accurate. I am satisfied that, within narrow limits, the abscissæ of viscosity are correct to the highest point, and the conformity of experiment to theory in the shape of these curves is a conclusive proof that, at as high an exhaustion as 0·02 M., the McLeod gauge is to be trusted to give accurate results within 2 per cent. of the truth. To give some idea what these high exhaustions mean, I may mention that the highest measured exhaustion—0·02 M.—bears the same proportion to the ordinary pressure of the atmosphere that a millimetre does to 30 miles, or in point of time, that one second does to 20 months.

In a highly exhausted tube the action is quite otherwise. Such a tube is before you (fig. 2), and in it I have carried the exhaustion to a high point (0·1 mm.). I pass the induction current and you perceive the electrified molecules, like the line of light in the first tube, also move in straight lines, and make their path apparent by impinging on a phosphorescent screen, D, E. If, however, I submit them to the action of a magnet, C, their behaviour is different. The line dips down to F, but does *not* recover itself. It seems that in the tube first shown we have to do with the average behaviour of the molecules of gas in its totality. In the second case, where the gas has been greatly attenuated, we are merely concerned with the behaviour of the individual molecules of which it was originally composed.

THE STRATIFIED DISCHARGE.

When the gas is rarer than is necessary to give the flexible line of light, as shown in the first experiment, the luminosity is plainly discontinuous, or, as it is termed, stratified.

A very good illustration of this fact may be taken from the moving crowd in any much frequented street—say Fleet Street. If at some time when the stream of traffic runs almost equally in both directions, we take our stand at a window from which we can overlook the passing crowd, we shall notice that the throng on the footway is not uniformly distributed, but is made up of knots—we might almost say blocks—interrupted by spaces which are comparatively open. We may easily conceive in what manner these knots or groups are formed. Some few persons walking rather more slowly than the average rate slightly retard the movements of others whether travelling in the same or in an opposite direction. Thus a temporary obstruction is created. The passengers behind catch up to the block and increase it, and those in front, passing on unchecked at their former rate, leave a comparatively vacant space. If a crowd is moving all in the same direction, the formation of these groups becomes more distinct. With vehicles in crowded streets the result, as every-one may have remarked, will be the same.

Hence mere differences in speed suffice to resolve a multitude of passengers into alternatings, gaps and knots.

Instead of observing moving men and women, suppose we experiment on little particles of some substance, such as sand, approximately equal in size. If we mix the particles with water in a horizontal tube, and set them in rhythmical agitation, we shall see very similar results, the powder sorting itself with regularity into alternate heaps and blank spaces.

If we pass to yet more minute substances, we observe the behaviour of the molecules of a rarefied gas, when submitted to an induction current. The molecules here are free, of course, from any caprice, and simply follow the law I seek to illustrate, and though originally in a state of rampant disorder, yet under the influence of the electric rhythm, they arrange themselves into well-defined groups or stratifications; the luminosities show where arrested motion with concomitant friction occurs, and the dark intervals indicate where the molecules travel with comparatively few collisions.

PARTI-COLOURED STRATIFICATIONS.

As another illustration of stratifications in a moderately exhausted tube (P. = 2 mm.), I will take the case of hydrogen prepared from zinc and sulphuric acid, after being passed through various purifying agents, dried in the usual manner, and exhausted with a mercury pump (fig. 3). I pass the induction current, and we see that the stratifications are tri-coloured, blue, pink, and grey. Next the negative pole, A, is a luminous layer, then comes a dark interval or Faraday's dark space (see below), and after this are the stratifications, the front component (*b*) of each group blue, the next (*c*) pink, and the third (*d*) grey. The blue discs are somewhat erratic. At a certain stage of exhaustion all the blue components of the stratifications suddenly

P = 6·0 mm.

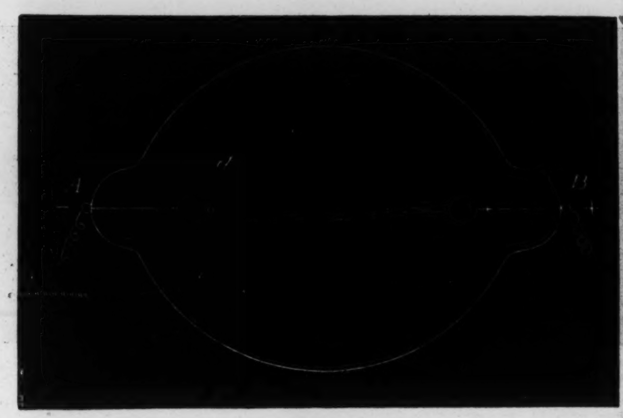

FIG. 5.

P = 3·0 mm.

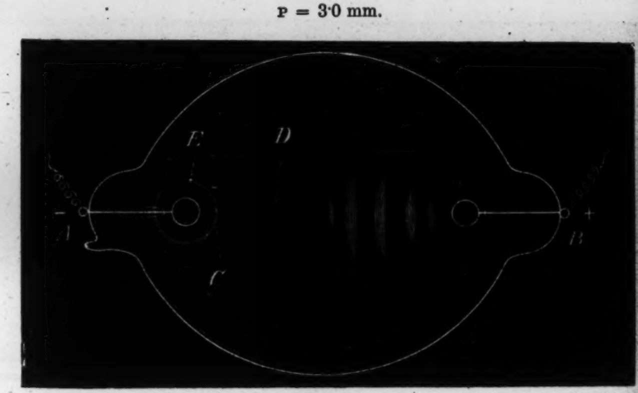

FIG. 6.

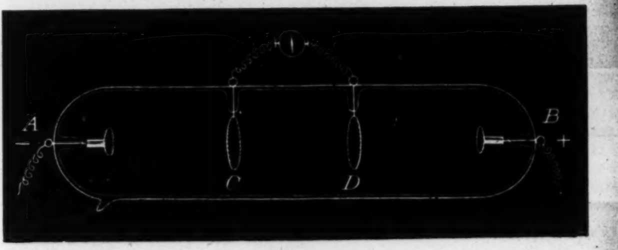

FIG. 7.

P = 0·25 mm. = 330· M.

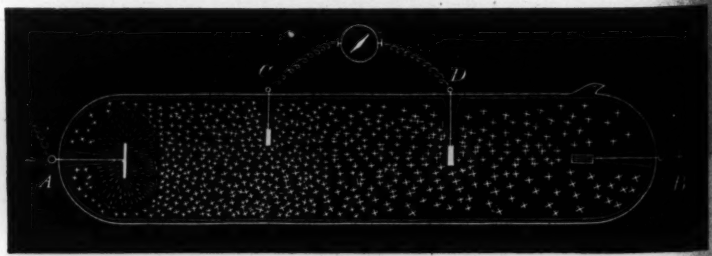

FIG. 8A.

P = 0·25 mm. = 350·0 M.

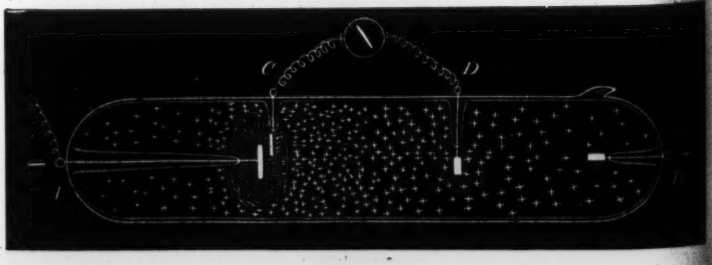

FIG. 8B

P = 0·25 mm. = 330·0 M.

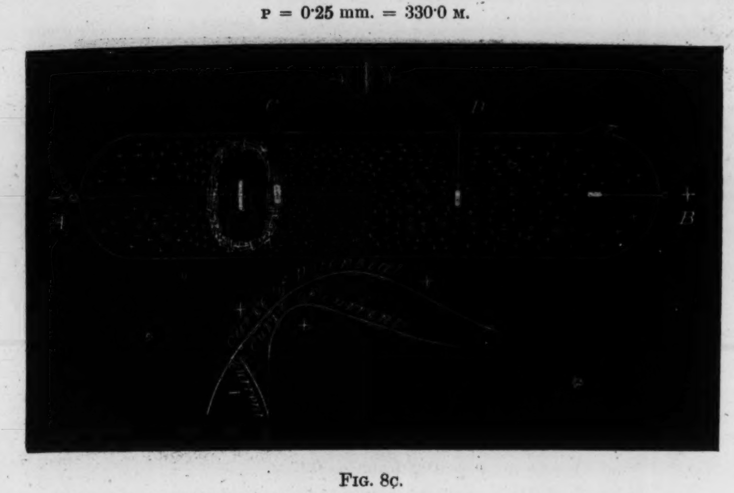

FIG. 8C.

P = 0·1 mm. = 131·5 M.

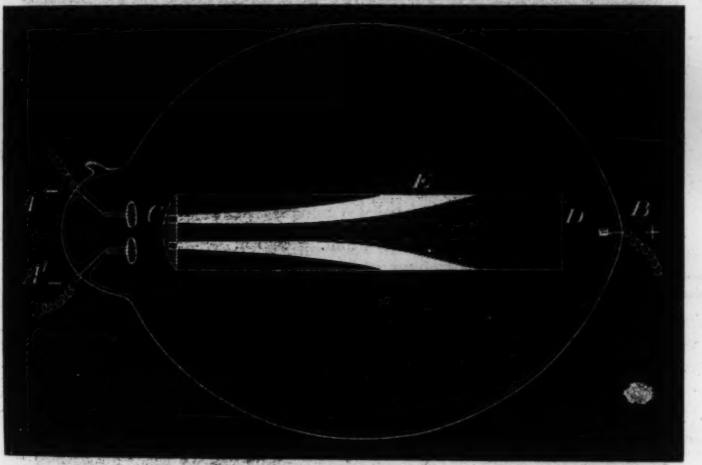

FIG. 9.

P = 0·0001 mm. = 0·13 M.

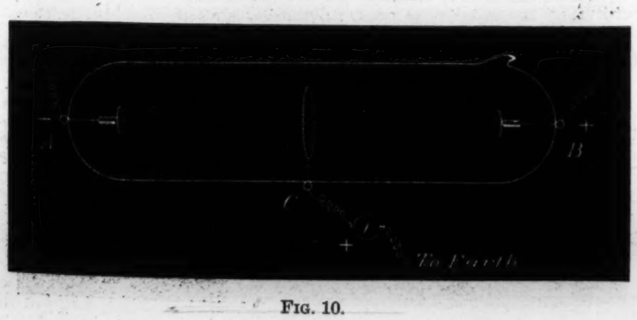

FIG. 10.

P = 0.001mm. = 1·3 M.

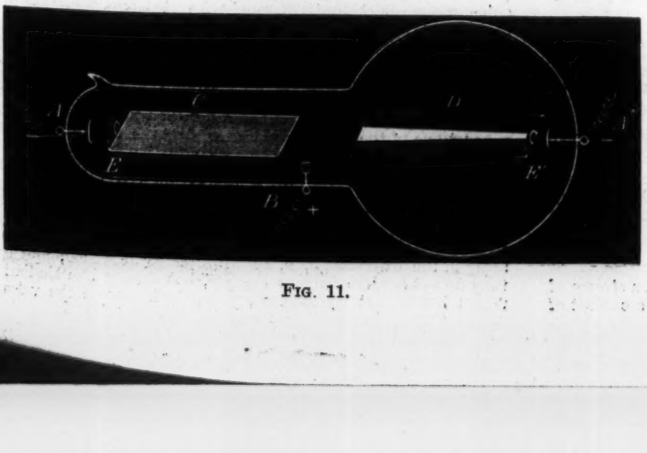

FIG. 11.

migrate to the front, forming one bright blue disc, and leaving the pink and grey components by themselves. The tube before you (fig. 4) is at this particular stage of exhaustion, and on passing the current you observe the blue disc only (*b*) is in front. When the tube contains a compound gaseous residue of this kind, the form of stratifications can be very considerably altered by varying the potential of the discharge. This alteration, in the forms of stratification, was first pointed out by Gassiot (1865, "B.A. Abstracts," p. 15), who gave very full descriptions and drawings of the alterations produced by putting in resistances of various lengths of distilled water. That the alteration depends simply upon the difference of potential the following experiment pretty clearly shows: Here is a tube giving on my coil the coloured stratification usually attributed to the presence of residual hydrogen, but which I find is due to a mixture of hydrogen, mercury, and hydrocarbon vapours. Now by altering the brake so as to produce frequent discharges of lower potential, you see the stratifications gradually change in shape and become all pink; again altering the brake so as to send less rapid discharges at a much higher potential, once more we get the coloured stratifications. When in this state, if we introduce a water resistance into the circuit so as to damp down the potential, exactly the same thing happens. The blue disc is caused by mercury; its spectrum is that of mercury only, without even a trace of the bright red line of hydrogen. Experiments not yet finished make it very probable that the pink discs are due to hydrogen, and that the grey discs indicate carbon. The tube you have just seen contains nothing but hydrogen, mercury, and a minute trace of carbon; but with all the resources at my command I have not been able to get hydrogen quite free from impurity. Indeed, I do not think absolutely pure hydrogen has ever yet been obtained in a vacuum tube. I have so far succeeded as to completely eliminate the mercury, and almost completely to remove the trace of carbon. On the table is such a tube giving uniformly pink stratifications and showing no blue or grey discs with any potential of current.

THE DARK SPACE.

After the stratification stage is passed we come to a very curious phenomenon, the so-called "Dark Space." Studying electrical phenomena in gases, in the year 1838, Faraday* pointed out a break in the continuity of the luminous discharge separating the glow of the positive electrode from that of the negative. This he called "the dark space." It it seen in tubes containing gas only slightly rarefied, as in this tube (fig. 5, P. = 6 mm.), where you will observe that the positive glow, extending as a pink streak from the positive electrode, B, ends about 10 millimetres before the spot of blue light, C, representing the negative glow. This gap, or non-luminous hiatus, D, is Faraday's "dark space." Separating the negative glow from its electrode in another space. In this tube it is so small that the glow appears to be in actual contact with the electrode, but on exhausting a little further it rapidly separates; and in the next tube (fig. 6), containing air at a little less pressure (P. = 3 mm.), this dark space, E, has extended so as to remove the negative glow about 4 millimetres from the electrode, A. It is with this second dark space that I particularly wish to deal to-night. Therefore I shall refer to it as the "dark space," meaning always that in the negative glow.

In the experiment just shown with hydrogen stratifications the contents of the tube under the electric discharge still obey the laws following from the average properties of an immense number of molecules moving in every direction with velocities of all conceivable magnitudes. But if I continue exhausting, the dark space, E, round the negative pole, A, becomes visible, grows larger and larger, and at last fills up the entire tube. The molecules at this stage are in a condition different from those in a less highly exhausted tube. At low exhaustions they behave as gas in the ordinary sense of the term, but at these high exhaustions, under electric stress, they have become exalted to an *ultra-gaseous* state, in which very decided properties, hitherto masked, come into play.

The radius of the dark space varies with the degree of exhaustion, with the kind of gas in which it has been produced, with the temperature of the negative pole, and to a less extent with the intensity of the spark.

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* "Experimental Researches in Electricity," 1838, par. 1,544.

It has been erroneously assumed that I ever said the thickness of the "dark space" represents the mean free path of the molecules in their ordinary condition, and it has been pointed out that the radius of the dark space is decidedly greater than the calculated mean free path of the molecules. I have taken accurate measurements of the radius of the dark space at different pressures, and compared it with the calculated mean free path of the gaseous molecules at corresponding pressures when not under the influence of electrical energy, and I find that they do not bear a constant relation one to the other. The length of the dark space is not 20 times the mean free path, as some have estimated, but a gradually increasing multiple must be taken as the exhaustion becomes greater.

EXPLORATION WITH IDLE POLES.

Wishing to learn something of the electrical condition of the matter within and without the dark space, I made a tube (fig. 7), having besides the positive and negative terminals, A B, two extra intermediate poles, C and D; the tube showed that when the exhaustion was such that both the idle poles were outside the dark space, on passing the current through the tube, there was a considerable difference of potential between them when measured on the galvanometer. If the exhaustion was carried so high that one of the extra poles was just on the border of the dark space, then no current passed between them. When the exhaustion was still further increased so as to enclose one of the extra poles fully in the dark space, again there was a great difference of potential between them, but the direction was reversed, the pole at highest potential now being the one formerly at lowest potential.

When a dark space has been further explored by means of a movable negative pole, I found that the effects did not depend essentially on the exhaustion, and were really due to the position occupied by the extra poles with regard to the dark space.

These phenomena are difficult to understand from mere description, and the experiments themselves are not easy to carry out so as to be visible to many at a time. I have here, however, a working model of an apparatus which will make these puzzling indications clear to all.

A cylindrical tube (fig. 8, *a*, *b*, and *c*, P = 0·25 mm.), furnished with the usual poles, A, B, at the ends, has two extra or idle poles near together at C and D. The pole A is movable along the axis of the tube, so that when exhausted the dark space can be brought to any desired position with respect to the idle poles C and D. The shading and + and − marks roughly show the distribution of positive and negative electricity inside the tube. I start with the negative pole, A, as far as possible from either idle pole (fig. 8, *a*). Turning on the coil you see the dark space surrounding the pole, A, and the idle poles quite outside.

The shading shows that each idle pole is in the positive area, and on testing with a gold leaf electroscope it will be seen that each is charged with positive electricity. But the shading also shows more positive at C than at D, and on connecting C and D with a galvanometer the needle indicates a rush of current from C to D, D being negative to C.

The dark space is next brought to such a position that the pole, C, is well within it (fig. 8, *b*). A change has now come over the indications. The galvanometer shows a reverse current to that which was seen on the former occasion. C is now negative and D positive, but the gold leaves still tell us both poles are positively electrified.

At a certain position of the dark space, when its edge is on the pole, C (fig. 8, *c*), a neutral state is found at which the gold leaves still show strongly positive electrifiations, and no current is seen on the galvanometer. The curves below (fig. 8, *c*), roughly show the rise and fall of negative and positive current at different parts of the tube, whilst the potential curve keeps positive.

When a substance that will phosphoresce under electrical excitement is introduced into the tube, the position of greatest luminosity is found to be at the border of the dark space, just where the two opposing armies of negative and positive atoms meet in battle array and re-combine. Later on I shall refer to this phenomenon in connection with the phosphorescence of yttria.

P = 0·0001 mm. = 0·13 M.

FIG. 12.

P = 0.0001 mm. = 0·13 M.

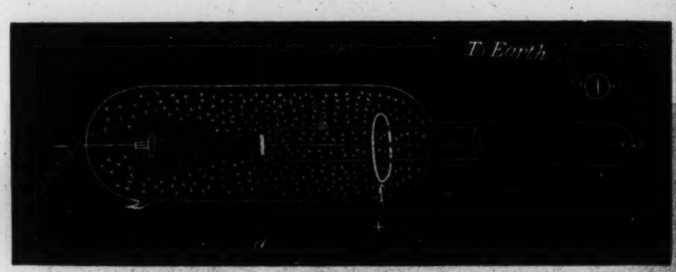

FIG. 13A.

P = 0·0001 mm. = 0·13 M.

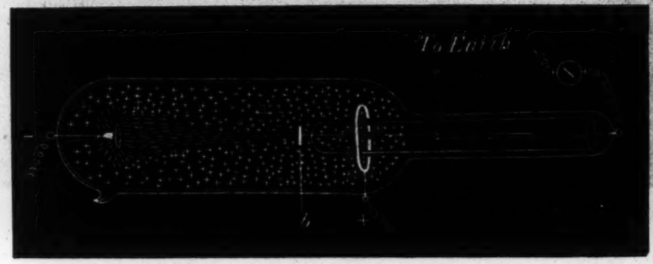

FIG. 13B.

P = 0·0001 mm. = 0·13 M.

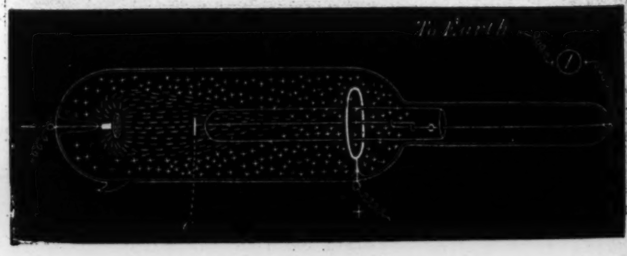

FIG. 13C.

RADIANT MATTER.

By means of this tube, fig. 9, I am able to show that a stream of ultra-gaseous particles, or radiant matter, does not carry a current of electricity, but consists of a succession of negatively electrified molecules whose electrostatic repulsion overbalances their electro-magnetic attraction, probably because their speed along the tube is less than the velocity of light. The tube has two negative terminals, A, A′, close together at one end, enabling me to send along the tube two parallel streams of radiant matter, rendered visible by impinging them through holes in a mica diaphragm on a screen of phosphorescent substance. It is exhausted to a pressure of 0·1 mm. I connect one of the negative poles, A, with the induction coil and the luminous stream darts along the tube from C to D parallel with the axis. I now connect the other negative pole, giving a second parallel stream of radiant matter. If these streams are in the nature of wires carrying a current they will attract each other, but if they are simply two streams of electrified molecules they will repel each other. As soon as the second stream is started you see the first stream jump away in the direction, C, E, showing strong repulsion, proving that they do not act like current carriers, but merely like similarly electrified bodies. It is, however, probable that were the velocity of the streams of molecules greater than that of light, they would behave differently, and attract each other, like conductors carrying a current.

To ascertain the electrical state of the residual molecules in a highly exhausted tube such as you have just seen, I introduced an idle pole or exploring electrode between the positive and negative electrodes in such a manner that the molecular stream might play upon it. The intention was to ascertain whether the molecules on collision with an obstacle gave off any of their electrical charge. In this experiment, fig. 10, P. = 0·0001 mm., or 0·13 M.,[*] it was found that an idle pole, C, placed in the direct line between the positive and the negative poles, A, B, receiving in consequence the full impact of the molecules shot from the negative pole, manifested a strong *positive* charge. In a variety of other experiments made to decide this question, the electricity obtained was always found positive on testing with the gold leaf or Lippman's electrometer, and when the idle pole was connected to earth through a galvanometer a current passed as if this pole were the copper element of a copper zinc cell, indicating leakage of a current to earth, the idle pole being positive. If, instead of sending this current to earth, the wire was connected to the negative pole of the tube, a much more powerful current passed in the same direction.

THE EDISON EFFECT.

An exactly parallel experiment has been made by Mr. Edison, Mr. Preece, F.R.S., and Prof. Fleming, using, instead of a vacuum tube, an incandescent lamp. They found that from an idle pole placed between the ends of the filament the electricity always flowed as if the pole were the zinc element of a copper-zinc cell; having repeated their experiments I entirely corroborate them. I get a powerful current in one direction from an idle pole placed between the limbs of an incandescent carbon filament, and one in the opposite direction from an idle pole in a highly exhausted vacuum tube. This discrepancy was extremely puzzling, and I tested, with a similar result, very many experimental tubes made in different ways. The electricity obtained from an idle pole placed between the positive and negative terminals in a highly exhausted tube was always strongly *positive*, and it is only recently that continued experiment has cleared the matter up.

Some of the contradictory results are due to the exhaustion not being identical in all cases. In my vacuum tubes the directions of current between the idle pole and the earth changes from negative to positive as the exhaustion rises higher. Testing the current when exhaustion is proceeding, there is a point reached when the galvanometer deflection—hitherto negative—becomes nil, showing that the potential at this point is zero. At this stage the passage of a few more drops of mercury down the pump tube renders the current positive. This change occurs at a pressure of about 2 mm.

After this point is reached, when the induction current is passed through the tube, the walls rapidly become positively electrified, probably by the friction of the molecular stream against the glass, and this electrification extends over the surface of any object placed inside the tube. I will show you how this electrification of the inner walls of the tube acts on the molecular stream at high vacua. In this tube, fig. 11 (P = 0·001 mm. or 1·3 M.), are fixed two exactly similar phosphorescent screens, C and D; at one end of each is a mica gate, E, E′, with a negative pole, A, A′, facing it. One of the screens, C, is in the cylindrical part of the tube and close to the walls; the other, D, is in the spherical portion, and therefore far removed from the walls. On passing the current the screen D in the globe shows a narrow sharp streak of phosphorescence, proving that here the molecules are free to follow their normal course straight from the negative pole. In the cylindrical part of the tube, however, so great is the attraction of the walls that the molecular stream is widened out sufficiently to make the whole surface of the screen, C, glow with phosphorescent light.

If an idle pole, C, C, fig. 12 (P = 0·0001 mm. or 0·13 M), protected all but the point by a thick coating of glass, is brought into the centre of the molecular stream in front of the negative pole, A, and the whole of the inside and outside of the tube walls are coated with metal, D, D, and "earthed," so as to carry away the positive electricity as rapidly as possible, then it is seen that the molecules leaving the negative pole and striking upon the idle pole, C, on their journey along the tube carry a negative charge, and communicate negative electricity to the idle pole.

This tube is of interest since it is the one in which I was first able to perceive how in my earlier results I always obtained a positive charge from an idle pole placed in the direct stream from the negative pole. Having got so far, it was easy to devise a form of apparatus that completely verified the theory, and at the same time threw considerably more light upon the subject. Fig. 13, *a*, *b*, *c*, is such a tube, and in this model I have endeavoured to show the electrical state of it at a high vacuum by marking a number of + and − signs. The exhaustion has been carried to 0·0001 mm. or 0·13 M, and you see that in the neighbourhood of the positive pole, and extending almost to the negative, the tube is strongly electrified with positive electricity, the negative atoms shooting out from the negative pole in a rapidly diminishing cone. If an idle pole is placed in the position shown at fig. 13, *a*, the impacts of positive and negative molecules are about equal, and no decided current will pass from it, through the galvanometer, to earth. This is the *neutral* point. But if we imagine the idle pole to be as at fig. 13, *b*, then the positively electrified molecules greatly preponderate over the negative molecules, and positive electricity is shown. If the idle pole is now shifted as shown at fig. 13, *c*, the negative molecules preponderate, and the pole will give negative electricity.

As the exhaustion proceeds, the positive charge in the tube increases and the neutral point approaches closer to the negative pole, and at a point just short of non-conduction so greatly does the positive electrification preponderate that it is almost impossible to get negative electricity from the idle pole, unless it actually touches the negative pole. This tube is before you, and I will now proceed to show the change in direction of current by moving the idle pole.

I have not succeeded in getting the "Edison" current in incandescent lamps to change in direction at even the highest degree of exhaustion which my pump will produce. The subject requires further investigation, and like other residual phenomena these discrepancies promise a rich harvest of future discoveries to the experimental philosopher, just as the waste products of the chemist have often proved the source of new and valuable bodies.

(To be continued.)

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[*] M. = one-millionth of an atmosphere.
1,000,000 M. = 760 mm.
„ „ = one atmosphere.

ALLEGED PRIMARY BATTERY SWINDLERS.[*]

C. D. COVELL was recently arrested at Council Bluffs, Ia., on the charge of obtaining money by false pretences. About a month ago two men, who gave their names as C. D. Covell and W. Bellard, rented a building in Council Bluffs, and represented that they desired to interest capitalists in a scheme of electric lighting which was bound to revolutionise modern methods of illumination. As the story is told in the charge against Covell, it is the old tale of the primary battery swindle. According to the complainants the defendant said he had a battery which cost only a few dollars to make. When it was filled with proper chemicals at a cost of 60 cents it would run 12 incandescent lights for seven hours each night, and a small motor for six hours each day for a period of seven months. It was explained, it is alleged, that the battery could be put into every house in the country where the owner had the ability to pay $90, and then the company that was to be organised would make a clear $80 on each one. The projectors wanted to organise a stock company, and for this purpose would place $10,000 worth of stock at 50 cents on the dollar.

A number of exhibitions were made which were inspected with great interest. A dozen incandescent lights which lighted an apartment obtained their current, apparently, from an ordinary looking cell in the exhibition room. One resident of the city was so delighted with the system of illumination that he contributed to the capital stock. It was subsequently learned, according to the complaint, that the current came not from the cells which were exhibited, but from a set of accumulators which had been located in an out-of-the-way corner. The storage batteries were taken from their hiding place in the morning, so the story goes, and were charged at an electric light station. When this fact was ascertained the contributor to the capital stock promptly instituted proceedings, and one of the principals was arrested. He denies that his scheme was a swindling project, but alleges, with vehemence, that his batteries will do all he has claimed.

NOTES.

Bristol and Electric Lighting.—Mr. W. H. Preece, who is advising the Bristol Town Council on the subject of electric lighting, has presented a report to the electrical committee. Having been abroad recently, Mr. Preece gives his experience of the electric light in various towns which he visited, stating that he was particularly struck by the brilliancy obtained at Florence. There the lamps are in the centre of the roadway, and, consequently, a much better illumination is secured. Mr. Preece suggests that the same system should be adopted in the central thoroughfares of Bristol, including Park Street, Clifton. The system will not, however, be adopted, for another that is proposed will, it is believed, be even superior to that which won Mr. Preece's admiration. The committee, who have received numerous communications from the proprietors of business establishments intimating their willingness to take the electric light as soon as the authorities are in a position to supply it, now await a report from the City Surveyor as to a site for a depôt.

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[*] *Western Electrician.*

Brighton Electric Lighting.—The General Purposes Committee of the Brighton Town Council have prepared a draft statement of objections to the provisional order which is being applied for by the Brighton Electric Light Company, with a view to its being forwarded to the Board of Trade and to the secretary of the company. It is stared therein that the Brighton and Hove Electric Lighting Company seek for power to construct and maintain electric lines and works, and supply electricity within a portion of the Municipal Borough of Brighton and the parish of Preston. Similar applications have been made in 1889 and 1890, but the Town Council has opposed them and they have been refused. It is now urged that the Corporation are *bonâ fide* carrying out the intention expressed by them in 1889; they have obtained sanction to borrow, and are spending £32,500 in the purchase of land as a site for a generating station and in erecting works and machinery and laying mains within the central and western parts of the borough. Further, the company propose to retain for a period of three years their existing overhead wires, the existence of which has already been a subject of some correspondence between the Board of Trade and the Corporation, and the latter submit that no powers of retaining these should be granted to the company.

Electric Lighting in Birmingham.—The installation of the electric light in the central area, for which Parliamentary powers have been obtained by the Birmingham Electric Light Power Company, is progressing almost as rapidly as the promoters expected. The amount of work yet to be done in the streets is comparatively small, and the disturbance of the surface of the roads and footpaths is practically over. The laying of the buried heavy mains was completed some time since, and during the last few days men have been busy at the manholes, threading through the culverts prepared for their reception the copper strips which form the lighter distributing mains. Not much of this work remains to be done. At the generating station in Albert Street fair progress is being made. The boilers are set, and the fixing of the engine is proceeding; but some portions of the work are at a standstill owing to the frost, which has made bricklaying difficult, and has absolutely stopped one essential part of the work—the completion of the chimney-stack. In the meantime, every operation which the weather does not hinder is being pushed forward, and it appears likely that nothing but a serious prolongation of the frost will stand in the way of the fulfilment of the anticipation that the electric light will be in use by the end of this month. Orders for over 2,000 lights have been received, and this is considered very good for a company that has not yet commenced. The work already done by the company includes a large amount in the "wiring" of premises which are to be lighted, including the Victoria Courts, the Grand Hotel, the Bank of England, Temple Row (premises of the late Staffordshire Joint-Stock Bank), the new building of the Prudential Assurance Company, in Corporation Street, and the Alliance Insurance Company's offices.

Electric Light in Madrid.—The palace of Las Cortes is to be electrically lighted by means of a separate installation, but the lighting of the House of the Senate will be supplied by one of the central stations. Every day some fresh establishments are adopting the use of incandescent lamps, while others which adopted the system a month ago have gone back to the use of gas. This action on the part of customers appears to be justified, as the companies are charging the excessive price of 1s. 3d. per unit, and make their customers pay double or treble the fair price for the fittings. This will probably cause the adoption of small installations with 500 to 1000 lamps, which will be of a suitable size for the lighting of the blocks of buildings let out in flats.

Electric Lighting in the City.—The Palatine Insurance Company, Limited, who recently purchased the fine block of warehouses and offices, situate 12, Wood Street, has decided to immediately introduce throughout the building an installation of the incandescent electric light. The agents for the letting of the property are Messrs. Alexander, Daniel, Selfe & Co., 34, Old Jewry.

Electric Light in a Lunatic Asylum.—The electric light has recently been installed in the new hospital villa erected in the grounds of the York Retreat. The installation comprises all the modern improvements in incandescent electric lighting, combined with some special adaptations desirable in a hospital for the treatment of the insane.

Electric Lighting of Southport.—Several companies gave notice of an intention to apply for provisional orders to supply electricity in Southport, but they have since dropped their applications, and the town clerk has been instructed to proceed with the application of the corporation.

Entertainment to Edison and Swan's Employés.—On New Year's Day the Edison and Swan United Company gave an entertainment to their *employés* at their works at Ponder's End. A tea was given to the younger folks (about 200) in the afternoon, and presents were distributed. In the evening the elder *employés* of the firm were provided with a substantial tea, which was followed by a concert and dancing.

Progress of Electro-motors.—The use of the electromotor is extending, and some day the supply of power to drive them will be a great business. Generating stations already exist where current is used for driving the motors, but no public mains have been laid down for the purpose. In Kensington, however, some large stores are about to supply themselves with electro motors for driving chaff-cutters, coffee-grinders, &c. which will be furnished with current from the electric lighting circuits.

Electricity in Agricultural Operations.—An agriculturist in the Western Pyrenees has built a small generating station, which supplies current to 180 16-C.P. lamps, for the lighting of the various farm buildings. In addition to this, the thrashing and other machines, pumps, presses, mills, &c., are actuated by electro-motros.

New Spanish Journal.—Senor D. Rafael Carrillo y Martos has retired from the management of *El Telegrafista Espanol*, and will shortly bring out a new journal bearing the title of *El Telégrafo Espanol*.

Electric Welding.—The Electric Welding Syndicate announces that it has entered into a contract for the purchase of all patents and improvements secured, or which may be obtained, by the Thomson Electric Welding Company of Boston, Mass. This, it will be remembered, is an answer to the question put in the REVIEW of the 2nd inst. as to the new welder brought out by the American company.

Town Councils and Electric Lighting Systems.—A method of arriving at a sound conclusion respecting the merits of any system of electric lighting is adopted by the Town Councils of New South Wales. All the local authorities in a given district meet in a conference to discuss plans and estimates for installations. In this way valuable information is imparted one to another. There is much in this plan to recommend to English Town Councillors.

Deaths from Electricity.—Last Sunday a boy at Lyndeburg, Virginia, caught hold of a guy wire attached to an electric light pole, and, receiving a severe shock, was killed instantly. On the day previous a workman at Boston, while engaged in replacing the globe of an incandescent light took hold of the metal ring instead of the glass end. The man received a strong electric shock, which killed him instantly. The connecting wire had to be cut before the ring could be detached from his grasp.

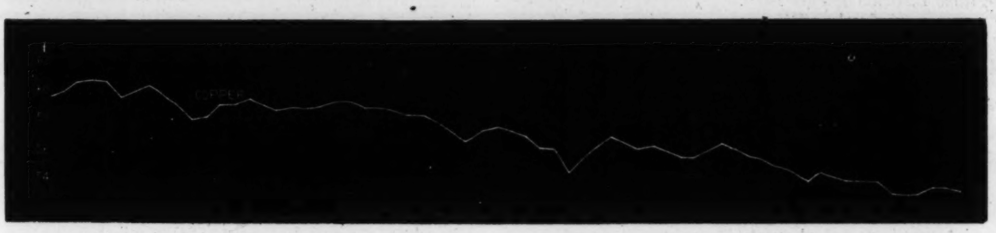
Rumoured India-rubber Syndicate.—It is rumoured in Boston that a syndicate of Englishmen and Americans, with a capital of from four to five million dollars is being formed for the purpose of buying up all the India-rubber in the world. It is said that the syndicate already possesses the monopoly of half the Para rubber, and that it intends to operate both in Great Britain and the United States.

Messrs. M. Theiler and Sons.—Many of our readers will, we feel sure, hear with much regret that, owing to the failing health of Mr. Richard Theiler, this gentleman has felt obliged to retire from active work in connection with the well-known firm of M. Theiler and Sons. The firm itself, as many of our telegraphic readers doubtless know, is almost of historic interest, the Theiler family having been connected with the progress of telegraphy from a very early period, and as manufacturing electricians and telegraph engineers they have acquired a world-wide reputation. Of Mr. R. Theiler himself we need say but little, as all who have had the pleasure of business and other dealings with him will greatly miss his genial presence. The business of the firm has, we understand, been acquired by Mr. Elphinstone, late assistant to Mr. Ferranti, who will carry on the work under (we are glad to hear) the old name, and who will, we do not doubt, prove a worthy successor to Mr. Theiler.

A Fishing Story.—The fishing story is a standing joke with American newspapers. The latest comes from San Francisco, where it appears that the ancient sport of attracting fish at night by a torch held over the water and spearing them has been revived in a somewhat different form. An electric light that stands by one of the wharves there attracts such numbers that people catch them in nets by the dozen. "One man," we read, caught 200 lbs. of fish, mostly rock cod and sardines, of unusual size."

More New Year's Gifts.—We return thanks for the blotting pad received from the Electric Construction Corporation and the date card from the Commercial Cable Company.

The Price of Copper.—The following is a diagram of three months' fluctuations in the price of copper. Each vertical line represents a market day, and each horizontal line £1.



Woodhouse and Rawson Staff Dinner.—The annual dinner of the head office staff of Woodhouse and Rawson United took place at the Guildhall Tavern on Tuesday last, under the presidency of Sir Rawson W. Rawson, K.C.M.G., C.B., chairman of the board of directors. The company numbered about a hundred and twenty, including representatives of some of the branch businesses. The proceedings of the evening were agreeably enlivened by music and song, Miss Rawson, Miss Fife, Mr. Stepney Rawson, and others contributing items that were much appreciated. In replying to one of the toasts, the managing director, Mr. F. L. Rawson, foreshadowed several schemes in contemplation for the comfort and emolument of the staff, including the establishment at the head office of a library and reading room, the annual award of £5 5s. for the best invention or suggestion emanating from the staff, and, later on, if at all practicable, some system of profit sharing. The general business manager, Mr. G. North, who gave some very good advice to the members of his staff, concluded by announcing that arrangements had been made for a series of lectures to be delivered to them on Friday evenings, commencing to-night with a lecture by Mr. Epstein, on "Secondary Batteries." It was stated during the evening that the total number of *employés* of the company now reaches a thousand.

Royal Society.—Last night, Prof. J. J. Thomson, F.R.S., was down for reading a paper "On the Rate of Propagation of the Luminous Discharge of Electricity through a Rarefied Gas."

The Electric Railway.—Says the *Weekly Dispatch* :—The electric railway is suffering from an excess of popularity. The eagerness of the people to travel by it has been amazing, and crowds block its stations at certain hours. They are so dense that the officials are not able to cope with them, and in places like Newington Butts they are becoming a severe hindrance to traffic. We predicted that this new line would be a tremendous success, and the promoters now regret that they had not more faith in their idea. It is the delightfully comfortable and roomy carriages, the absence of compartments, the absence of class distinctions, and the uniform fare that have captivated the public, and the directors will now be forced to extend their carriage and station accommodation, we fear at great expense. Surely the revolution in town travelling which this railway has introduced ought to convince the managers of the old companies that they must abandon their present policy if they want to make money.

A Trifling Mistake.—The *Elektricitäts-Zeitung*, which has now become a "daily," is going ahead with a vengeance. In its issue of January 4th, under the heading "Accident on the London Electric Railway," we read that a German lady, on the 29th December, met with a fatal mishap between Sloane Square and South Kensington Stations. It is not necessary to enquire how the electric line found its way into the tunnel of the Metropolitan Railway.

Telephonic.—Mr. A. Erskine Muirhead has established telephonic communication between Cathin Park and the *Glasgow Evening News* offices. The French telephone has been adopted with the greatest satisfaction, and it is expected that shortly the *Evening News* will be in telephonic communication with the more important football fields in the West of Scotland.

Electric Light in Kensington Town Hall.—The introduction of the electric light in the Kensington Town Hall was inaugurated on Thursday evening, last week, by a conversazione, under the auspices of the Vestry of the parish, the hall being tastefully decorated for the occasion with a variety of palms. Sir A. Borthwick, in asking Lady Mary Glyn to inaugurate the electric light, remarked that the current had been supplied to the building by the Kensington Company who were the pioneers of electric lighting in London. The gas, by which, till then, the hall had been lighted, having been lowered, Lady Mary Glyn turned on the electric current amid the applause of the company. The Rev. the Hon. E. C. Glyn then thanked the Lord Mayor for his presence. The Lord Mayor, in responding, said that Kensington was before the City in the matter of electric light, but the City would very shortly have the new light in the streets. The installation, which comprises about 350 lamps, was entrusted to Messrs. Bailey and Grundy, and the plans and specifications were prepared by Mr. Philip Monson, A.I.E.E., the Vestry's lighting engineer, and the work was carried out under his directions.

Electrical versus Hydraulic Power.—Our contemporary, *Engineering*, calls attention to the fact that the new Chilian ironclad, *Captain Pratt*, just launched from the la Seyne works of the Forges et Chantiers de la Mediterranée Companies, has its turrets so constructed as to be worked by electricity instead of hydraulic power.

Change of Address.—The Empire Telephone Company has changed its offices from 60 to 171, Queen Victoria Street, E.C.

"Underground Cables."—The following communication, from Mr. Charles H. Yeaman, has come to hand too late for insertion in the columns set apart for correspondence:—"Owing to my having been away from Liverpool, I have only just had a chance of referring to the letters from the Fowler-Waring and Silvertown Companies, and from Mr. Ferranti, which firm replies to my letter to you on the 5th ultimo. The inaccuracy of the Silvertown Company is shown in the first paragraph of Mr. Tyler's letter, in which he remarks that the letter published was from his Liverpool agent. That was not so; it was included in my communication to you referring to "Notes on Central Station Lighting.' With regard to my statements, I had just visited the West Brompton Station of the House-to-House Company before writing my paper, and had seen the Fowler-Waring cables in service, and had been told by the engineers of that company the *facts* which I put forth to the engineering fraternity in this city. I have had some practical experience of Fowler-Waring cables myself, and therefore do not wish to see a good article condemned without a hearing. I have been recently informed by good authority that the House-to-House Company find these cables very satisfactory, and propose to use them largely in future work, where space can be obtained for jointing. With regard, secondly, to the London-Deptford cables, I believe—and have good grounds for my statement—that where two Fowler-Waring cables have been used for 10,000 volts, they have stood this tension well, so long as not more than 5,000 volts existed across the dielectric. Is it quite certain that the statements in the REVIEW quoted by Mr. Tyler referred in each case to Fowler-Waring cables? Have no other cables broken down on this service? Lastly, I gave a true copy of the letter to me from the local manager—not *agent*—of the India-Rubber, Gutta-Percha and Telegraph Works Company, and if *he* omitted anything in his letter which ought to have been inserted to cause the true sense of Mr. Ferranti's opinion to be made known, he was furnishing false information to my corporation, as the communication was a perfectly official one on his part. Thus "was the sense of the paragraph entirely altered." With due consideration to the Silvertown Company, I think it is generally known that they make most excellent cables, and turn out first-class material for *inside* wiring, as well as the most expensive conductors which are on the market.—

Bulling Brush Shares.—The *Daily Oracle* seems to take a very great interest in Brush shares. Every day something to the following effect occurs in its columns:—*Rise.*—Brush: We again repeat what we have before said as to the prospects of these shares, and we believe that at any moment we may see a very sharp rise, as the time cannot be very far distant when subsidiary companies will be announced." For our own part, we should have thought that the subsidiary company dodge, so far as the Brush Company is concerned, a thing of the past. It is, of course, well known that the City contracts will have to be financed by a separate company, but we believe the Brush Company will benefit chiefly, if not solely, by the work which those contracts will bring. The *Oracle* should be more guarded in its apparently interested forecasts."

The Mutual Telephone Company, Limited.—Early next month this company will open for traffic the first section of its Manchester Telephone Exchange, and hopes to get to work in Liverpool very soon afterwards. The object in view is not so much to reduce rentals as to provide a really good telephonic service, which shall be expeditious and free from all disturbing noises, and which shall enable two subscribers to converse with each other without risk of being overheard by others. This will be accomplished by the use of two wires instead of one. Special attention is also being devoted to the making of rapid connections, and such perfection is said to have been already attained, that if the subscriber who is called is within hearing of the bell, and answers promptly the caller will obtain connection practically instantaneously, and after the conversation is over, special appliances will be provided, by means of which a conversation with another subscriber can be immediately begun without the trouble of "ringing off."

Telegraphists' School of Science.—An interesting gathering took place on Wednesday afternoon in the Postmaster-General's Deputation Room at the General Post Office, the occasion being the fourteenth annual distribution of the medals, prizes, and certificates gained by the students of the Telegraphists' School of Science, which was established at the Central Telegraph Office in 1876. The chair was taken by the controller, Mr. H. C. Fischer. The report showed that the school is satisfactorily fulfilling its intended purpose, viz., the provision of technical training for the staff of the Central Telegraph Office. At the examination in technical telegraphy held under the auspices of the City and Guilds of London Technical Institute, 67 certificates were granted to the numerous schools throughout the kingdom, and of this number 27 (or 40 per cent.) were awarded to the students of this school, who also obtained two of the three silver medals (with money prizes) offered for competition; 63 per cent. of the certificates were first class. The successes in the pure science subjects, which are supplementary to the technical section, were also very numerous, and of an equally high standard. Mr. Preece complimented Mr. Slingo (the principal of the school) and his staff on the continued success of the institution, and dwelt forcibly upon the value of sound technical education among the general body of the staff in assisting the British Telegraph Administration in maintaining its pre-eminent position. The chairman observed that the fact that a higher technical knowledge is now demanded of a telegraphist than in years gone by, to enable him to successfully control the present delicate and complicated apparatus, weighed heavily with the authorities in determining the recent improvements in the status and pay of the telegraph staff.

The Institution of Electrical Engineers.—On Thursday, January 22nd, at the ordinary general meeting, a paper on "The Distribution of Electricity, with especial reference to the Chelsea System," will be read by Major-General C. E. Webber, C.B. (Ret.), R.E., Past President.

Lecture.—On Saturday, January 10th, a popular lecture was given the schoolroom of Essex Church, The Mall, Notting Hill Gate, by Mr. Reginald J. Jones, A.M.I.C.E., M.I.E.E. (engineer to Messrs. Woodhouse & Rawson United, Limited), on electricity, entitled, "How Electricity Works for Us." In concluding, the lecturer remarked that he had to thank Messrs. Woodhouse and Rawson United, Limited, the Electric Construction Corporation, and the General Electric Traction Company, Dr. Silvanus Thompson, Messrs. Appleton, Drugman, Room, and other friends, for their kindness in lending apparatus and slides; no less than 45 slides were shown by means of an oxy-hydrogen lantern, and the experiments throughout were most successful. The whole of the room was lit by means of E.P.S. cells and incandescent lamps.

What We are Coming To.—Says *Ironmongery*; "We firmly believe that, so many and so varied are the uses, great and small, to which electricity may be economically put, every manufacturing or business house, most private offices, and the majority of dwellings will in time employ it for some purpose or many purposes. We hope that long before that time comes the public users of electricity will send as naturally to the ironmonger to put up a fresh installation, repair an old one, or provide some new and ingenious time or labour-saving appliance, as they send now to the plumber to overhaul a leaking water pipe, or make a new connection." To this end our contemporary has just commenced a series of articles, "Electrical Work for Ironmongers," which it hopes may be found of such value that there will be no difficulty in following their guidance successfully. But is it complimentary even to an ironmonger to compare him with the plumber, that *bête noir* of every householder's existence, and is he ever sent for with the faintest belief that he really knows anything about his trade? Furthermore, in discussing the expiry of the telephone patents, *Ironmongery* speaks jubilantly of the fine opportunity offered to the members of the trade who may make this field practically their own, because not much knowledge of electricity is required to compass it. The occupation of the electrical engineer is, like that of Othello, evidently gone.

The Electric Construction Corporation.—This body is offering for subscription £100,000 first mortgage debentures to bear 6 per cent. interest. This issue is made in consequence of the "growth of business," and for the purpose of extending its operations and repaying a banker's advance of £30,000 (secured by temporary debentures), &c. Messrs. Farebrother, Ellis, Clark and Co.'s valuation notwithstanding, we do not think the security any too good. The Corporation, it will be remembered, was established in May, 1889, with a capital of £500,000 (all of which has been issued), to purchase and amalgamate the following undertakings, viz:—Elwell-Parker, Limited; The Electrical Power Storage Company, Limited; The Railway Electrical Contractors, Limited; The Julien patents, for the United Kingdom, for electric traction; the Sprague patents, for the United Kingdom, for electric traction and transmission of power.

It might have been Worse.—A contemporary states that during the recent fire in Queen Victoria Street an iron pole, carrying some 30 telephone wires, came down with a crash. "Had any of these," it remarks, "been electric-light wires, fearful damage might have ensued." No doubt; and if the telephone wires had been gas mains the conflagration might have been worse. Had they been water mains, the fire might have been more rapidly extinguished.

Inventors' Institute.—On Wednesday last Mr. C. Spagnoletti delivered a lecture on "The Electric Locking and Blocking of the City and South London Railway," Mr. J. W. Grover in the chair. The lecture was illustrated by models and drawings. It was listened to attentively by an audience, which included several gentlemen holding foremost positions in the railway world. A discussion followed.

French Exhibition at Moscow.—A French exhibition will presently be held at Moscow, which will be divided into nine groups. Machinery and electric lighting will form the seventh group.

A Handsome New Year's Gift.—Mrs. F. C. Guilleaume, of the firm Felten and Guilleaume, Mulheim-on-the-Rhine, has presented the staff of the company with 200,000 marks (£10,000) in cash as a New Year's gift. Two years ago the same lady gave them 100,000 marks.

Messrs. Cox and Company.—These manufacturing electricians have opened new premises at Fetter Lane, opposite the Record Office, where they intend keeping a stock of apparatus and materials for all scientific work. They have also issued illustrated lists of each department; the electrical, which gives details of telephone parts, should be specially useful.

Curious Phenomena.—The letter which Mr. Hewlett sends to us is interesting, and shows that he is on the alert to observe anything unusual in the behaviour of apparatus under his control. The peculiar effect of his experiment on the filament of the lamp is possibly due to a static cause, or to the action of currents upon themselves, the loop in the filament making it into a kind of helix. The vibration is, of course, attributable to the fact that the filament is a conductor carrying an intermittent current in the influence of a powerful magnetic field. Perhaps some of our readers can enlarge upon the phenomena observed by Mr. Hewlett, and possibly a reference to the address of Mr. Crookes may be found of service.

General Electric Company.—The company has just issued the eighth edition of its Electric Bell and Accessories Catalogue, the contents showing the adoption of several improvements, combined with some material reductions in prices, resulting from the long experience of the company in manufacturing. The recent expiration of the Bell telephone patent has created a new branch of the General Electric Company's business, and a special catalogue dealing with the latest developments in telephones is promised shortly.

More Scientific Killing.—The New York Court of Appeals has affirmed the judgment given in the case of three murderers sentenced to be executed by electricity.

Failure of the Electric Light at Chelmsford.—A local paper says that on Monday evening for several hours the principal streets in Chelmsford, from the top of Moulsham to the Red Cow, were in darkness, owing to a breakdown in the circuit which includes the whole of the arc electric lights.

English as She is Spoke.—In *Annales Télégraphiques* for September—October, 1890, on page 435, we have an extract from a paper by Mr. Preece with reference to experiments on the heating of wires by the electric current; in this extract we have reference to La Compagnie de Lumière Electrique, "Eas Hourne," also we are informed that one of the specimens of wire experimented on was supplied by MM. John Fawles et Ce., and that able assistance was given by M. Lowice. Our readers will, perhaps, recognise the names "Eastbourne," "Fowler," and "Lowrie" in the extraordinary conglomeration of our contemporary. Sir William Thomson's name, of course, is spelt "Thompson." Our lively neighbours, whose knowledge of "Lord Smiff" and "Sir Bradlaugh" is so intimate, are once more putting us right.

Personal.—Mr. Egerton H. Clarke has joined the board of the St. James' and Pall Mall Electric Light Company, Limited.

Elmore's Copper.—We have received a lengthy letter on this subject from a former correspondent, "An Original Shareholder," which will appear in our next.

Appleton, Burbey and Williamson.—We have received a copy of Messrs. Appleton, Burbey and Williamson's illustrated price list and catalogue, which has been thoroughly revised, and in which the prices are considerably reduced since its last issue. The list is issued in sheets, but the copy sent us is admirably adapted for reference, being arranged in a box file, with spring slip, allowing of the ready insertion of any additional sheets as published. The firm have now taken large works at Horsleydown, and fitted them with complete and expensive machinery, in the hope of being able in future to successfully compete with the foreign manufacturer.

Prof. Ayrton's Lectures.—The course of lectures at the Central Institution for outside students, by Prof Ayrton, which have been announced in our business columns as commencing on Wednesday last, do not in reality start practically until Monday afternoon, the 19th inst. Prof. Ayrton devotes the first lecture of each term to going over the examinations set at the end of the preceding term, and this is what took place on Wednesday.

The Electric Light at Exeter.—The decision of the Council of the "ever faithful city" to apply for a provisional order for the manufacture and supply of electricity, has evoked considerable opposition among the ratepayers, chiefly on the ground that an electric lighting company being already in existence, it was unwise for the council to proceed in the matter, and unfair also to the pioneers in the movement. It was argued that if a provisional order were granted to a private company the council would not, as had been stated, lose all control over the streets. At a meeting of ratepayers held last week it was proposed and seconded "that in the opinion of this meeting of ratepayers it is undesirable for the council at present to undertake the production or supply of electricity for lighting purposes, or to promote a provisional order for that purpose." A member of the Council argued that the Electric Lighting Acts and rules showed that it was the intention of the Legislature to place in the hands of the local authority the power of lighting their districts with electricity. He also pointed out that after obtaining the order the Town Council might offer it to the electric lighting company on lease, on fair, just, and equitable terms. At the close of the discussion the resolution in opposition to the action of the Council was adopted by about three to one.

Colorado Electrical Street Railways.—The *Scientific American* says that electricity as a street car motor is rapidly superseding other mediums in Western cities. Denver has already 30 miles of electrical street road in operation, employing an aggregate of 1,150 horse-power of generators, 38 motor cars, each fitted with two 15 horse-power motors, and 60 trailers, traversing the city and reaching out in every direction to suburban points. The old cable and horse car companies are rapidly adopting what is apparently to be the motive power of the future for all city and suburban traffic. Several additional electric lines are in contemplation. Some are already in process of construction, notably the so-called Suburban line of 15 miles and the Golden line of 21 miles mentioned in a previous issue. The West End line uses double-truck cars 40 feet long and of 2,000 lbs. weight, fitted with two 15 horse-power Sprague motors, this motor and overhead wires being in general use on all the lines. The Colorado Springs electrical main line, with branches, is 22 miles long, and runs to Colorado City, the former capital of the State; to Manitou, connecting with the new steam railway to the summit of Pike's Peak, altitude 14,150 feet, and to numerous other points of interest. The aggregate power of the generators of this line is 280 horse, employing 18 motor cars and a like number of trailers. The various lines are all doing a large and an apparently increasing and profitable business.

Electric Transmission of Power in Wurtemberg.—The Royal Foundry at Königsbronn in this province has substituted electric motors for steam power for the driving of 25 lathes and polishing machines. At the side of the source of the Brenztopf there has been erected a turbine, which actuates a dynamo running at 600 revolutions, and giving 40 H.P. The current is led by overhead conductors across the town to the foundry.

Electric Light in Panama.—A financial contemporary says:—"Panama, being disappointed in the matter of the canal, has turned to other ventures; it is about to light its streets by the aid of electricity, and it is once more exploiting its pearl fisheries. The first enterprise is really too ridiculous. What is there to illumine in Panama but dirt, disease, and desolation? The pearl fisheries may be more promising. They used to be the historic, and very profitable, industry of Panama. It was exhausted, and for a long time has been left to neglect; now it is once more booming, and Panama, after a long spell of distress and commercial stagnation, seems likely to experience a little prosperity."

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Gülcher (New) Electric Light and Power Company, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 9th inst. The nominal capital is £70,000 divided into 20,000 ordinary and 50,000 preference shares of £1 each, the whole of which are taken up, the former being credited as fully paid. Upon 23,352 preference shares the full amount has been called, and half the amount upon the remaining 26,648 shares. The calls paid amount to £36,481 6s. 4d., and unpaid to £194 13s. 8d.

Electric Construction Corporation, Limited.—The annual return of this company, made up to the 22nd ult., was filed on the 7th inst. The nominal capital is £500,000 divided into 100 founders' shares and 49,900 ordinary shares of £10 each, the whole of which are taken up, 4,900 being considered as fully paid. Upon the remaining shares the full amount has been called, the total of the calls paid being £438,640, and unpaid £12,360.

Portsmouth and South Hants Electricity Supply Company, Limited.—At an ordinary general meeting of the shareholders in this company, held at the George Hotel, High Street, Portsmouth, on the 12th ult., it was resolved to wind up voluntarily; and at a meeting held at 13, High Street, Portsmouth, on the 30th ult., the resolution was confirmed, and Mr. Wm. Edmonds, of 46, St. James's Street, Portsea, chartered accountant, was appointed liquidator. The special resolution was duly filed on the 8th inst.

MacIvor's Patents, Limited.—The statutory return of this company made up to the 2nd ult., was filed 8th ult. The nominal capital is £250,000 in £2 shares. 37,500 shares are taken up and the full amount has been called thereon. The calls paid amount to £46,696 5s., and unpaid to £28,303 15s. Registered office, 11, Queen Victoria Street.

Electricity Supply Corporation, Limited.—The annual return of this company made up to the 6th inst., was filed on the 8th inst. The nominal capital is £100,000 divided into 9,900 ordinary and 100 founders' shares of £10 each. 259 ordinary shares have been taken up, and upon 209 the full amount has been called, and upon 50 shares £1 has been called. The calls paid amount to £2,140.

Devon and Cornwall Electricity Supply Company, Limited.—The annual return of this company made up to the 3rd inst., was filed on the 8th inst. The nominal capital is £100,000 in £5 shares. 42 shares are taken up, and the full amount has been called and paid thereon, the calls paid amount to £210. Five shares have been forfeited, but no payment has been made thereupon.

Freedman Battery Company, Limited.—The statutory return of this company made up to the 2nd inst., was filed on the 6th inst. The nominal capital is £2,000 in £1 shares. 1,865 are taken up, and 5s. per share has been called and paid thereupon, the paid up capital thus being £466 5s. Registered Office, 276, Strand.

CITY NOTES.

Eastern Telegraph Company, Limited.

SIR JOHN PENDER presided at the 37th half-yearly meeting at Winchester House yesterday. The following report had been in circulation among the shareholders some days:—

The revenue for the period amounted to £352,873 11s. 1d., from which are deducted £91,723 11s. 7d. for the ordinary expenses and £31,477 17s. 9d. for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £5,212 8s. 2d. for income tax, there remains a balance of £224,459 13s. 7d., to which is added £2,484 9s. 7d. brought from the preceding half-year, making a total available balance of £226,944 3s. 2d.

From this balance there have been paid—

	£	s.	d.
Interest on debentures and debenture stock	28,274	13	0
Dividend on preference shares	20,474	3	9
Two interim dividends of 2s. 6d. per share each on ordinary shares	100,000	0	0
	£148,748	16	9

Leaving a balance of £78,195 6s. 5d., which is carried forward to the next account.

The revenue includes £33,455 17s. 8d. dividends for the half-year upon the company's shares in the Eastern and South African, the Black Sea, the Direct Spanish and the African Direct Telegraph Companies.

The directors learn that the negotiations referred to at the last general meeting with certain of the Australasian Colonies for effecting a reduction in the tariff will be speedily concluded, and tho new rates will be brought into operation at an early date.

The directors have decided, in view of a largely increased traffic with Australasia, to lay a triplicate line from Aden to Bombay, and have entered into a contract with the Telegraph Construction and Maintenance Company for the manufacture and laying of the cable early in the present year.

The new Red Sea cable connecting Suez, Perim and Aden, referred to in the last repart, was successfully laid by the contractors in November last. Arrangements have been made to take the direct Suez-Aden 1876 cable into Suakim, thus duplicating the Suakin-Suez section, and adding to the security of submarine telegraph communication with that port.

In accordance with the articles of association, two of the directors, Sir John Pender, K.C.M.G., and the Marquis of Tweeddale, retire by rotation at this meeting, and, being eligible, offer themselves for re-election.

The auditors, Mr. Henry Dever and Messrs. Welton, Jones & Co., retire, and offer themselves for re-election.

The CHAIRMAN, after referring to the figures in the report, considered it was a most satisfactory statement. Telegraphy was a never sleeping, ever-moving system; and often they had not been at business an hour when the news of a cable breaking would arrive. Nowadays, however, they looked upon such a thing as a matter of course, the anxiety which was once felt was now absent. Hitherto they had always paid a satisfactory dividend, and he trusted it would always be the case. The capital of the company had not been increased to any great extent; but still cables had been laid down of a value approaching a million pounds sterling. This had been derived from the reserve. It was these facts which accounted for the high value of the shares of the company on the market. They had always striven to keep ahead of the wants of the public, and when it was found that there was an agitation on foot in Australia to reduce the rates, the company ably backed it up. They had duplicated, triplicated, and quadrupled many of the cables upon their systems in pursuance of their policy of being ahead of requirements. He had told them on previous occasions that that was their strength. When the Australian colonies had made a new departure and endeavoured to get the rate reduced from 8s. to 4s., the directors had felt that if the effort was to be successful they must practically double the amount of traffic over the system, for the Australian traffic had been so largely carried over it that it would never do to be left behind. They were about to lay a new cable in the Red Sea which, with one already laid this year, would give them three cables to Bombay, which would enable them to carry successfully the large increase from Australia which they looked forward to. They had duplicated twelve cables, triplicated one, and quadrupled two, for, as he had always said, a single line could not be relied on. The line ought to be duplicated or triplicated, and if it were quadrupled it would be so much the stronger. He had referred to the African traffic, which had not been very great. Those who had been watching the Dark Continent, and noting the speculation carried on there, had never supposed it could live for ever; but it was not likely to die out altogether, and there was already evidence of another movement, and no doubt as the system moved so would the traffic move onwards. Extensions were going on, and practically without issuing new capital. In this expenditure they were adding very, very materially to the value of their property, and he hoped they would be able to continue the present dividends and increase their bonus. The Chairman concluded by moving a resolution that the report and accounts be received and passed, which the Marquis of Tweeddale seconded, and which was unanimously carried. These two gentlemen, who were retiring by rotation, were then re-elected, and the auditors were re-appointed.

A vote of thanks to the chairman was moved by Mr. Hurst, and seconded by Dr. Waller, who referred in his speech to the eloquent speech of the chairman, and the still more eloquent silence of his audience. This was carried by acclamation, and Sir John Pender having returned thanks, the meeting came to a close.

Elmore's French Copper Company.

M. Secretan on the Position and Prospects of the Company.

The statutory meeting of this company was held at Cannon Street Hotel, last Friday, under the presidency of Lieut.-General Meade.

The Chairman said: Gentlemen, all present are doubtless aware that this is only a statutory meeting of the company, held to fulfil the requirements of the Companies Acts, and not for the transaction of business. We propose, however, to ask the meeting to sanction certain alterations in the articles of association, of which due intimation is given in the notice convening the meeting, which are required by the Committee of the Stock Exchange. I have stated that we are not here to-day for the transaction of business, but we are glad to have the opportunity of meeting our fellow-shareholders, and of informing them of what has been done since its formation to carry out the objects of the company. I have first to state that the 66,750 shares offered to the public were applied for about four times over, and that a full allotment was made among some 2,000 applicants. The sums due on allotment have, with a small exception, been all paid up, and those still outstanding on the first and final calls are in course of adjustment. The Stock Exchange Committee has granted a settlement for our shares, and, provided this meeting passes the alterations in the articles of association of which notice has been given, there will be an official quotation of our shares on the London Stock Exchange at a very early date. Steps are also being taken to introduce our shares upon the Paris Bourse, which will, no doubt, be successful, and thus lead to an important extension in the dealings in our shares. The first question your directors had to deal with was that of the general management of the company's manufactories and business in France, and they congratulate the shareholders on their having been able to secure the very valuable services of Monsieur Eugene Secretan as the company's general manager there. M. Secretan was formerly manager of the largest copper manufacturing industry in the world, and your directors are confident, from all they have learned and know of him, that in placing him at the head of the company's affairs in France they have taken the most important step that was possible towards securing the complete and early success of the business of the company in that country. M. Secretan was, it was understood, convinced of the merits of the Elmore process when it was exhibited in Paris in 1889, and before entering the service of the company he visited the works of the English company at Leeds, accompanied by several colleagues, and his assurances to the board, after making that visit, of his entire confidence in the future success of our company, were most emphatic and satisfactory. As stated in the prospectus, your directors had secured for the company land at Bellegarde, near the Swiss frontier, suitable for a site for the works, with water available as a motive power, but M. Secretan was so satisfied of the vast importance of establishing a manufactory, and commencing business at first in the north of France, that, after much anxious consideration, we accepted his recommendation on this point, and decided to concentrate our attention and efforts on the establishment of works there, in the first instance, on a sufficiently large scale to admit of a more considerable outturn of manufactured goods than was originally contemplated. M. Secretan gave us the strongest assurances that he would be able to dispose of all the goods that would be thus turned out, and he was accordingly authorised to take the necessary steps for securing a convenient and suitable site, for the preparation of plans and estimates of the buildings that would be required, and for ordering the engines, machinery, and plant needed to stock the works. These arrangements he has carried out with characteristic energy, and we are able to inform this meeting that an excellent and convenient site, of ample extent, has been obtained by him on very advantageous terms at Dives, near Havre; that the plans and estimates for the buildings to be erected thereon have been approved and sanctioned by the board, and that the engines, machinery, and plant have been ordered from the best manufacturers of such articles in France. The winter season will, of course, delay the progress of the buildings, but M. Secretan states that the works will be in operation by 1st July next. M. Secretan, who is present here to-day, will address the meeting. I may mention that he has secured the assistance of a committee of experts in Paris, whose aid will be most valuable in the work that lies before him. I will now refer to the financial aspect of the more extended operations your directors have authorised. The prospectus provided for a working capital of £50,000, which, it was thought, would be quite sufficient for starting the works successfully on a moderate scale. But it was at once apparent that the adoption of M. Secretan's proposals would necessitate a large increase to this amount, and, after much consideration, we decided to avail ourselves of an offer from the parent company (the Elmore Foreign and Colonial Company, Limited), to lend to us for this purpose £50,000, at 6 per cent. per annum, for three years. The shareholders were informed of the circumstances of this arrangement by a circular issued to them on 29th October last. I have only to add that we are satisfied that the course we have thus taken was the best that it was in our power to adopt in the interests of the company. The measures now laid before the meeting will enable the company to retain in its own hands—instead of disposing of the same to a sub-company, as was intended—the exclusive license to make copper wire in France by the Elmore process. The value of our shares should be largely increased by such retention, as the profits from the manufacture of wire will by and bye be very considerable. The patents which we have purchased have been duly transferred to us, and we have every assurance that the same are perfectly good and valid. The company obtains, free of charge, all improvements worked out from time to time by the Elmore English Company in this country, and I may mention, in this connection, that one additional patent on this account has already been taken out by us in France. It only remains for me to say that the board has the fullest confidence in the future success and prosperity of the company. I or my colleagues will be happy to answer any questions that may be put to us before I propose the resolution for the alterations in our articles of association. I have the pleasure, before sitting down, to introduce M. Secretan to the meeting.

M. Secretan, who spoke in French, said: I am very sorry I cannot express myself in English, and I trust some member of the board will kindly translate the few words I ask permission to address to you. Gentlemen, the board of your company has expressed a wish that I should be present at this meeting. It is with great satisfaction that I have complied with that request, because, on the one hand, it permits me to thank your directors publicly for the honour they have conferred upon me by appointing me general manager of your company in France; and, on the other hand, I thought you would be glad to hear a few words from me on the present and future position of your company. The extended and careful investigations and trials that have been made up to the present time have convinced me and my most trustworthy and competent advisers that the Elmore process has definitely reached a practical manufacturing stage. You have the exclusive right to manufacture under this process in France, and the articles produced are of extraordinarily good quality, and the cost of production is extremely low, more so, indeed, than is stated in the prospectus. These facts being now incontestable, the time for hesitation has passed, and that for work has arrived. I have submitted to your board plans for the erection of the first factory, and I had the good fortune to see them fully approved. Immediately after this approval, I entered into arrangements with excellent contractors for the erection of the buildings, and with the most competent manufacturers for the machinery and plant. There will be no hitch in the completion of your factory, as too often happens. To avoid this, I have only dealt with firms of the highest standing and the greatest experience, who are renowned for the scrupulous carrying out of their engagements. With these I have entered into definite contracts at prices which are absolutely binding, and cannot be exceeded. Under these contracts the buildings will be handed over complete at the end of next April. Engines, boilers, dynamos and plant generally will be erected, in working order, by the end of June, and on the 1st July next your first works in France, constructed to produce 370 tons of copper articles per month, will commence work, and will, at the end of another three months, have reached their full production. I need not tell you that the sale of these articles is absolutely assured. Supported by the confidence of your board, seconded by my French Committee of Direction, and aided by a staff, of whose industry and goodwill I cannot speak too highly, I undertake, as far as I am personally concerned, to work with untiring energy and with entire devotion to your interests. In conclusion, I can assure you, gentlemen, that you can regard the future with absolute confidence and faith in the prosperity of your company.

Dr. Hetley asked whether the increased capital of £50,000 was in debentures or preference shares, and whether they might not have been offered to the shareholders of the French Company instead of being otherwise distributed.

Mr. Lawes said he had not the pleasure of M. Secrétan's acquaintance, but knew that he had been on the management of a metal company in France, and he should like to know what the profits of that company had been for a certain amount of time previously. (Laughter.) His address seemed to him to be no practical demonstration of the way in which the business was going to be carried out.

The **CHAIRMAN**: You cannot expect a reply to your question surely. We have no means of giving you the information you ask; we only know M. Secretan's experience has been very great in the particular business in which he has now taken service with us.

Mr. **LAWES** said in the prospectus a great point was made about the water-power, by which this process was going to be worked on a very low scale; but that idea appeared to have been thrown to the wind by the changed locale of the company. He also thought the shareholders ought to have some share in the debentures, and that 6 per cent. was an outrageous price.

Mr. F. L. **RAWSON** said as the last speaker seemed to have thrown some doubt on M. Secrétan, he should like to say that his firm, Woodhouse and Rawson, had the highest opinion of that gentleman's great capacity as a metallurgist and of his knowledge of business as a manufacturer. When he found that there was a chance of M. Secrétan coming as manager to the company, he said, "The future of the company is assured."

The **CHAIRMAN** said he was informed that the Foreign Elmore Company, which had lent the £50,000 on debentures, would be very glad to issue those debentures to any shareholders of the French Company who were willing to take them up. It had been impossible for the directors to enter into any part and parcelling in regard to the debentures. The great object they had in view was to secure the possession of a sufficient sum of money to enable them to start what M. Secrétan assured them was necessary for the success of the company. They could only do that by accepting the arrangement offered by the Foreign Company to give them the £50,000 on the terms named. He could only say they came to the conclusion they did after great consideration, and they were perfectly confident that they had done the best they could for the company. A question had been asked about the use of water-power at Bellegarde, but he had explained that matter to the meeting. They had secured a site at Bellegarde with water-power, but it was impossible for them to commence two manufactories at once, and the weight of evidence in favour of starting in the first instance in the north of France was so conclusive that they were compelled for the present to put Bellegarde aside; but they still retained their interest at Bellegarde, and when the proper time came, and they had money sufficient to try a second factory, they proposed to start there.

Mr. **RAWSON** said the profits of the Société des Méteaux were £240,000.

The **CHAIRMAN** said, with regard to the resolutions, they were merely formal, and related to alterations to the articles which the Committee of the Stock Exchange required. He proposed: "That the following words be added to Article 15, at the end thereof: 'Provided that 21 days' notice at least shall be given of each call, and that no call shall exceed one-fourth of the nominal amount of a share, or be made payable within two months after the last preceding call was payable.'"

Major **JONES** seconded the motion, which was carried unanimously.

The **CHAIRMAN** next moved: "That the following words be added to Article 44, at the end thereof: 'Provided that the directors shall not, without the sanction of a general meeting of the company, raise or borrow any sum of money which will make the amount raised or borrowed by the company and then outstanding, exceed one-half of the subscribed capital of the company, and so that every debenture, debenture stock certificate, mortgage, or other charge shall be under the common seal of the company.'"

Mr. C. **PHILLIPS** seconded the motion, which was agreed to.

The following was also proposed by the **CHAIRMAN**, seconded by Major Jones, and carried: "That the following words be added to Article 116, at the end thereof: 'A printed copy of such balance sheet shall, seven days previously to the meeting, be sent to the members in the manner in which notices are hereinafter directed to be served.'"

The **CHAIRMAN** intimated that a meeting to confirm the resolutions would have to be held in about a fortnight, but of this due notice would be sent to the shareholders.

Sir **RAWSON RAWSON** proposed a vote of thanks to the Chairman.

Mr. **CALLENDAR** seconded the motion, which was carried.

The **CHAIRMAN** assured the shareholders that they would have the very best efforts of the directors in making the company a success.

On the motion of Mr. **CHIRAC**, a vote of thanks was accorded M. Secrétan for his remarks.

The proceedings then terminated.

Woodhouse and Rawson United, Limited.

ON Friday last, an extraordinary general meeting of Woodhouse and Rawson United, Limited, was held at Winchester House, Old Broad Street, to consider, and, if thought fit, pass two extraordinary resolutions, one authorising the directors to arrange with the liquidators of Woodhouse and Rawson, Limited, for the immediate or early repayment to them of £75,000, which they had deposited with the company to be retained till the 1st of July, 1892, as a dividend guarantee fund, and another increasing the capital of the company to £550,000, by creating 40,000 new shares of £5 each—20,000 preference and 20,000 ordinary.

The **SECRETARY** having read the notice convening the meeting,

The **CHAIRMAN** (Sir Rawson Rawson, C.B., K.C.M.G.), said about a year ago he had had the honour of occupying the chair, and of expressing to them at their statutory meeting his confidence that the company would realise fully the expectations of its promoters, the promises of its prospectus, and the hopes of its shareholders. He was happy on this occasion to have the opportunity of repeating the confidence of the board that the success which had hitherto attended the company would be maintained. It would be in the recollection of the shareholders that Lord Aberdare—whose separation from that board the directors continued to regret—stated his opinion very confidently that the capital of the company was insufficient; his colleagues were of the same opinion, and they would have addressed the shareholders upon the subject at an earlier period, had not the financial crisis stopped everything of the kind for some weeks past. There were two objects in the resolutions that had been circulated, and which the shareholders had had the opportunity of examining. The first was to enter into such arrangements as the directors might think advisable with the liquidators of Woodhouse and Rawson, Limited, for the refunding of the loan of £75,000 made by them to Woodhouse and Rawson United, Limited, as a guarantee that for three years the shareholders should be secured 8 per cent. upon preference shares, and 15 per cent. upon ordinary. They would have seen in the first year's balance-sheet that the profits of the year, after paying these rates of dividend, and, of course, paying the debentures, left a surplus of £41,000, which was equal to about a year and a half of the annual payments at these rates to the shareholders. Of the three years for which the guarantee fund had been left in their hands, a year and a half had already elapsed, and it was time to consider how that sum should be repaid. It had not been lying idle in the directors' hands. It had been invested in the purchase of other business, and employed as working capital, and they must look forward to the repayment of it at the end of eighteen months. The directors considered that it was convenient, when asking the shareholders to increase the capital for general working expenses, to propose at the same time an arrangement for repaying the limited company the loan upon advantageous terms. He had hoped to be able to tell them that the affair was arranged, but it had not been arranged up to the present moment; still the directors hoped to make such terms with the company that the shareholders would derive positive profit from the early repayment, and would get rid of what he considered a heavy burden—the liability of repaying the sum in cash at the end of 18 months. The directors felt confident that the security for the shareholders for those three years was perfect. One year had elapsed, and they had paid at the rate they undertook; another half-year had elapsed, and their profits had not been less than the year before. Their expectations of the coming six months were not less favourable, and they would therefore at the end of the second year not only have paid the shareholders at the rate of 8 and 15 per cent., but they would have another surplus to add to the £41,000 wherewith to pay the shareholders at the end of the third year. They were not pledged beyond the third year, but their hopes certainly extended beyond that period, and the directors hoped and trusted that at the end of the three years they would not be in a worse position than now to satisfy their shareholders with a large and abundant profit. These were the grounds upon which the directors asked permission to make terms if they considered them favourable to the company. They would not make terms unless they were fair and favourable. They were not bound to repay the money before the end of the 18 months, and would not do so if it was to be a disadvantage to the company; but if it was to the shareholders' advantage they would ask their sanction to the measure. The second point was, that the capital of the company be increased from the present amount to £550,000 by the creation of additional shares. When the company was brought out the working capital asked for was decidedly a moderate one. The promoters were satisfied that they would be able to show such a rate of profit as would justify them in coming before the shareholders and saying, "You see what we are earning. If we had a larger capital we shall not only be able to earn as much—we will improve upon it;" and he believed that the shareholders will have enough confidence in the board to meet that appeal and furnish the capital. Since the last eighteen months the business of the company had largely increased. Yesterday the earnings of the supply department had been put into his hands. The second six months were 50 per cent. over the first six months, the third six months were 30 per cent. over the second six months. The company must hold in hand a large and very varied stock of electrical goods to meet the demand of the customers, and, moreover, must have a very large outstanding account. The shareholders already knew that the directors had increased the business by the purchase of a very expensive business to enable that company to hold a prominent position among the electric companies of England. In order to secure that, and that they might be independent of other people, they found it necessary to manufacture and supply all the more important articles required by their customers. For these reasons they wanted an increase of capital. It was not, however, proposed to raise the increased capital at once; all the directors asked was the shareholders' sanction for the sum stated, in order that they might be prepared at the proper time. As regarded debentures, the articles of association empowered them to increase the issue to the extent of £250,000. Inasmuch as the value of money was decidedly lower than it had been, they thought 6 per cent. too high, and it was intended to recall existing debentures, and to issue a larger sum, probably £200,000, instead of the present £100,000, at 5 per cent. He would draw the shareholders' attention to one point, the issuing of shares while those already issued were at a slight discount. The shares ought to be about par, but difficulties in settling the affairs of Woodhouse and Rawson, and in getting a quotation for the shares on the Stock Exchange, had prevented. However, when the public found that the profits made last year were not accidental or casual, but would be maintained, they would have restored confidence in the concern, and the shares would be taken at their proper value. Some of the shareholders might say that the directors should not ask for more capital while half the ordinary capital of the company was still uncalled. There were three good reasons why the directors should not call up the capital; the first was that their ordinary shareholders had been allowed to think that it was not the directors' intention to call for it without it were absolutely necessary; another was that the directors had thought it wise to keep the capital in reserve for purposes of repaying the loan to the limited company—the loan having been absorbed in the business of the company for general expenses and extension of business, and the third reason was that a company carrying on such a business as theirs ought to keep a reserve fund of this kind upon which, when opportunities of useful extension presented themselves, they could at once borrow money. It was always available as a security for moneys loaned by bankers, and so made it unnecessary for them to keep a large balance at the bankers, yielding the small rate of interest that money now fetched. He had not much more to say regarding the resolutions, but he had satisfaction in calling the shareholders' attention to the success which had attended the company both in the matter of the Elmore shares and of the International Okonite Company. Every day confirmed the statements made with regard to the value of the Elmore process, and the success of the two foreign companies, the French and the Austro-German, was assured. The International Okonite Company was about to declare a 10 per cent. dividend upon the work of the six months they had been in operation, and this had been before the Manchester Company was able to erect works and commence operations under the okonite patent in England, so that the success, so far as profits were concerned, was substantiated to the fullest. These were companies in which Woodhouse and Rawson United had been interested, and it was such companies that it was desired to promote, not untried processes and chance patents, but patents and processes which they had amply tested by their staff and in the factories. Their manner of taking them up secured them from any risk beyond the expenses of launching the companies, and that shareholders need not be afraid that the directors would embark in any rash undertaking calculated to risk the capital. With regard to their own factories, they had leased one of their blocks of buildings to the Kensington Stores, and taken another nearly double as large. The frost had prevented them from putting the engine and boiler in, but they hoped that before long these would be at work. They had a number of new machines ready to work as soon as they were able, and he anticipated that in future the profits from that branch of their business would be very much larger than they had hitherto been. He hoped the interim dividend would be declared in a few days. The chairman concluded by moving the first resolution, which was seconded by the Rt. Hon. Sir Edward Thornton, G.C.B.

Mr. SQUIRES thought it would be impossible to get people to pay full price for new shares while the old ones could be bought at a discount, especially as the old shares had the advantage of the guarantee fund. If more capital was required, he thought the uncalled capital should be called up.

Mr. ABRAHAMS having spoken,

Mr. HORSFIELD said that he knew a considerable number of shareholders in the North who spoke very strongly about giving up the dividend guarantee fund. They had subscribed to the company expecting to receive 15 per cent. for three years, and so getting at least 45 per cent. of their money returned. They had heard a good deal of the success of the company, but nothing as to how that success had been obtained. What proportion of the profits had been obtained from legitimate trading and what from speculation, promotion, or what else they liked to call it. They had only received a dividend for 12 months, as yet, and though the directors were confident of the future, they all knew how much they could have dropped by only one unfortunate undertaking. Their shares at the present time were nearly unsaleable, and even then at a discount of 15 or 20 per cent. What would they be worth if they gave up the security for the next two years' dividend? He was not aware that any part of the guarantee fund had been received in cash, and if they were going to pay it back in that form—it was folly to think of paying it back at all—the shareholders should be sure they were paying back something they had actually had, and not paying for shares or secured loan or other form of fund. If they raised capital to pay off this guarantee fund, it would be an extra weight for the company to bear, while at present they had the use of money for nothing. He complained, also, of the delay in getting an official quotation on the Stock Exchange.

Messrs. HOSTER and MONTEZUMA continued the discussion, and

Mr. CHAPMAN spoke urging that the credit of the company would be better if it could be shown that a considerable proportion of its profits were earned, or likely to be earned, in the ordinary way of business. Last year's profits were somewhat incidental, they would not expect Elmore or Okonite Companies to turn up every day.

Mr. FREDERICK L. RAWSON (the managing director) replied. He said: First of all the proposed increase of capital was an extra security for the debenture shareholders; secondly, the depreciation which had taken place in the shares was very largely due not only to the financial position—if they looked at any industrial securities, they would find they had fallen 10 per cent. or more—but also because during the last six months they had been paying out to the companies the shares they were entitled to under the agreements made. During the past fortnight or month £80,000 of capital had been put upon the market, and that had been the principal factor in keeping shares down, but they had been steadily rising for the past few days. A shareholder had referred to Mr. Baker, their works manager, having sold his shares. He had spoken to Mr. Baker, and it seemed he had been paid altogether in preference shares when the company purchased his business, and he had to realise a certain amount of those shares to obtain money to settle his own business, but had been buying ordinary shares ever since. He, himself, had taken up £28,000 preference shares during the past six months. They could have no better proof of his belief in that company. The directors might have been thought speculative in purchasing four businesses in 18 months, but they wanted to put that company in the position of being able to manufacture every class of electrical goods, except cables. With regard to new companies, they might separate themselves from ordinary company promoters, for they had been connected with only three, and were connected with them for some 12 or 18 months or two years, till that business came out as a company. They were not new affairs. They had mentioned in their last report that they had three inventions in the process of testing; these had turned out successfully. They had commenced making one, and would continue till it got beyond their powers when they would turn it into a company. Since then they had a new electrical invention being tested. The demand for motive power had increased, and, like the electric light, he thought it had "come to stay." With regard to the repayment of the £75,000, they proposed to repay either in cash or debentures, whichever was most advantageous to the company. If they gave £75,000 in debentures at 5 per cent., it would only add £3,750 upon the expenditure, a very small amount out of a margin of profit of £41,000, as they had last year, and supposing they got a discount of 10 per cent., they would have a profit of something like £5,000. With regard to the issue of new shares, of course, the directors only asked for power to do so, and would issue them whenever the market was most favourable. This new capital would also be an additional security for the debentures; they could not possibly issue £200,000 5 per cent. debentures on the present capital. It would be overweighting the concern. Referring to the dividend guarantee fund, he said they had already earned more than enough to pay the dividend for the whole year, so that they could not possibly call upon more than a very small portion of the reserve fund. They need not go into speculative business, and during the past year had not gone into a single piece of business involving them in a liability of £10,000. The uncalled capital was a valuable security, and enabled them to work with some £10,000 in the bank, instead of £30,000 or £40,000. Another speaker had said they could not expect Elmore or Okonite companies every day; but there was another class of company being brought to them. Businesses of the highest class were brought to them by people who could have brought them out themselves, but preferred that Woodhouse and Rawson United should bring them out for them.

The resolutions were put, seconded, and carried, and the usual vote of thanks concluded the meeting.

The Direct United States Cable Company, Limited.

THE report of the directors for the six months ended 31st December, 1890, to be presented to the 27th ordinary general meeting of the company, to be held at Winchester House, to day, at 2 p.m.

The usual statements of account for the half-year ended 31st December, 1890, are submitted herewith.

The half-year's revenue (subject to revision on decision of the case mentioned below), after deducting out-payments, amounted to £43,346 13s. 7d. against £42,356 12s. 1d. for the corresponding period of 1889, being a difference of £990 1s. 6d. in favour of the half-year under review.

The working and other expenses for the half-year with income tax, and including the expenses of the New York office entirely borne by this company (*vide* paragraph 6 of the report to 30th June last), but exclusive of cost of repairs of cable, amounted to £17,555 12s. 7d., leaving a balance of £25,791 1s. as the net profit, making with £968 0d. 3d. brought forward from the previous half-year, a total of £26,759 1s. 3d. For the corresponding period of 1889, the working expenses and other payments amounted to £15,509 5s. 8d.

Interim dividends of 3s. 6d. per share for the quarter ended 30th September, 1890 (paid 24th October, 1890), and of 3s. 6d. per share for the quarter ended 31st December, 1890 (payable 24th January, 1891), together amounting to £21,248 10s., have been declared, and the balance of £5,510 11s. 3d. on the revenue account has been carried forward.

An interruption of the main cable, occasioned by a vessel's anchor, occurred on the 1st September last, near the Green Bank, and was repaired on the 8th September. The repairing operations have cost £1,629 12s. 5d., which has been charged to the reserve account as heretofore.

In the case of the Anglo-American Telegraph Company *v* Cie. Française du Télégraphe de Paris à New York, the Appeal to the Council of State, mentioned in the report to 30th June, 1889, is still pending.

Portsmouth and South Hants Electricity Supply Company, Limited.—The London *Gazette* gives notice that the creditors of the above company are required on or before the 14th day of February, 1891, to send their names and addresses, and particulars of their debts or claims to me, William Edmonds, of 46, St. James Street, Portsmouth, in the County of Hants, Chartered Accountant, the liquidator of the said company, and, if so required, by notice in writing from me, are to come in and prove their said debts or claims, at my offices as above, within such time as shall be specified in such notice, or in default thereof they will be excluded from the benefit of any distribution made before such debts are passed.—Dated this 9th day of January, 1891.

Vice-president of the Commercial Cable Resigns.—Mr. Hector De Castro has resigned the vice-presidency of the Commercial Cable Company in order to become the secretary of the Inter-Continental Railway Commission.

Globe Telegraph and Trust Company, Limited.—The directors have declared an interim dividend of 1s. 9d. per share.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 9th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,434.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended January 9th, 1891, amounted to £5,487.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (January 8).	Closing Quotation. (Jan. 15).	Business done during week ending January 15, 1891.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	97 —100 xd	98 —101	99¼	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	49 — 50	49¾	49
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	85 — 86	85½— 86½	86¼	85¼
2,809,310*l*	Do. do. Deferred	Stock	13¼— 13¾	13¼— 13¾	13 9/16	13⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11 — 11½xd	11¼— 11¾	11 9/16	11¼
84,500*l*	Do. do. 5 p. c. Bonds	100	102 —104	102 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	102 —106	102 —106	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2 — 2½	2¼— 2½	2½	2 5/16
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1¾— 2	1½— 2	1 15/16	1¾
$7,216,000	Commercial Cable, Capital Stock	$100	102 —104 xd	104 —105	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	11½— 12	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	3 15/16	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜xd	10 7/16	10 3/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14¼	14 — 14¼xd	14¼	14 1/16
70,000	Do. 6 p. c. Preference	10	14¾— 15¼	14¾— 15¼xd	15⅛	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	108 —111	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	104 —107	105 —108	106¾	105½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅛— 14⅜	14¼— 14½xd	14⅜	...
320,000*l*	Do. 6 p. c. Debentures, repay February, 1891	100	101 —103	101 —103	...	...
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105 xd	102 —105	104½	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105 xd	102 —105	104¾	...
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 —104 xd	101 —104	...	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104 xd	101 —104	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	100 —102	100 —102	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7 — 7½	7 — 7½	7½	7⅛
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4¾— 5¼	4¾— 5¼	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	4 — 4½	4 — 4½	4¼	3½
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¾— 2¼	1¾— 2¼	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8¾— 9	9 — 9¼	9 1/16	8 15/16
180,042	Do. do. 6 p. c. Preference	10	14⅝— 14⅞	14¾— 15	14 15/16	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	15¾— 16¼xd	16½— 17	16¼	16 1/16
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	... ... xd	105 —108	...	...
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,800	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½	19	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	100 —102	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37	37	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	9½— 10	9¼— 9¾	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9½— 10	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£8 paid)	10	7¾— 8¼	7¾— 8¼	8⅛	7⅞
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4 9/16	4 3/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	12 — 12½	12¼— 12¾	12 11/16	12¼
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10— 10½	10— 10½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	⅛— ⅜	⅛— ⅜	...	...
9,000	Reuter's Limited	8	8½— 9	8½— 9	...	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2¾— 3¼	2¾— 3¼	...	...
3,381	Submarine Cables Trust	Cert.	110 —114	110 —114	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅞	4⅝
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	45	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 —102 xd	100 —102	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 95 xd	90 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ... xd	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9 xd	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	98 —101	100½	98¼
30,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	3⅛	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —102	97 —102	...	...
64,174	Western and Brazilian Telegraph, Limited	15	10¾— 11¼	10¾— 11¼	11¼	10¼
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼— 6¾	6¼— 6¾	6¾	6⅝
27,873	Do. do. do. 5 p. c. Deferred	7½	4½— 5	4¼— 4¾	4⅝	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	105½	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	2¾— 3	2¾— 3	2 15/16	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11¾	11¼— 11¾	11⅞	11½
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11 — 12	11 — 12	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103	103	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	2½— 3	3½— 4	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2⅜—2⅝.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅞—2⅛.—Manchester Edison and Swan Company, £3 (£1 paid) 11s.—13s.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 1⅞—2⅛.—Preference, 4⅜—4⅝.

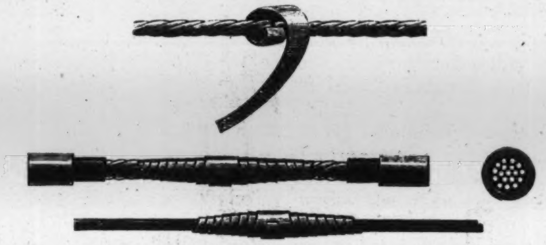
BANK RATE OF DISCOUNT.—4 per cent. (8th January, 1890).

BERGMANN'S NEW CONNECTOR FOR ELECTRICAL CONDUCTORS.*

NEXT to the quality of the conductor itself, the most important part of an electric circuit is the joint by which its various lengths are connected to form the complete lines. In all classes of electric work the joint has been found to exercise a not inconsiderable influence on the working efficiency, and as a result we find that constant efforts are being made to improve not only the quality but the ease of accomplishing the union of two ends of a conductor. A good joint should have two important attributes, namely, a conductivity and a tensile strength at least equal to that of the rest of the circuit.

To combine both of these merits with facility in making the joint, the Bergmann Electric and Gas Fixture Company, of this city, have just brought out a unique connector which is specially adapted to the jointing of heavy wires, such as those employed in electric lighting, railway and welding conductors.

The connector employed for this purpose consists simply of a strip of No. 34 sheet copper tinned on both sides, made in various widths and lengths, tapering at one end to about 1½ to 2 inches in width and also slightly tapering towards the other end. The manner of its application is illustrated in fig. 1, which shows a stranded cable about to be wrapped, fig. 2 showing the completed joint, and fig. 3 a section of the same. Fig. 4 shows the connector as applied to a solid wire.



FIGS. 1, 2, 3 AND 4.

BERGMANN'S CONNECTOR FOR ELECTRIC WIRES.

In order to make the joint conveniently and rapidly, use is made of a simple clamp stand, which is illustrated in fig. 5.

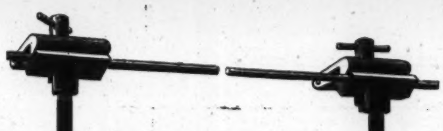


FIG. 5.—THE CLAMPING STAND.

The two ends of the cable or conductors to be joined are tightly clamped in the jaws on the stand and the ends brought to within about $\frac{1}{16}$ inch of each other; the handle in the middle of the stand then being given a turn, the two ends are brought up close to each other. Then by means of a soldering iron or torch, one end of the copper strip is soldered to the cable, and the strip wrapped tightly around the cable ends, acid being applied to each layer. The end of the strap is then bound together by iron wires, about ¾ of an inch apart. The whole connector and cable ends are then heated with a good flame and solder applied, after which the iron wires are removed, leaving a perfect joint.

It will be readily seen that the conductivity of a joint made in this manner is fully as great as, if not greater than that of the conductor itself, and in order to demonstrate its mechanical strength we give below the results of tests made at Columbia College on samples of a No. 2 silicon bronze wire having an area of ·043 square inch.:

	Breaking Stress.	Area of Complete Joint before Fracture.	Diam. of Joint.
No. 1	2,140 lbs.	·169 sq. in.	·465 in.
No. 2	2,080 „	·165 „ „	·459 „
No. 3	2,800 „	·155 „ „	·445 „

The normal breaking stress of the wire was 3,490 lbs.

It will be noticed that the connector increases the diameter but comparatively little at the joint, which is of special importance in insulated conductors. On the other hand the connector is admirably adapted to overhead trolley lines, the joint being perfectly smooth and round and presenting no obstacle whatever to the passage of the trolley wheel.

Another practical convenience, we need only add is that the connector can be applied to any size or style of cable or bar, without requiring a special size of connector for each variation in the diameter of the conductor.

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* New York *Electrical Engineer.*

ACCUMULATOR AND HORSE TRACTION.

A FEW months ago, in an article entitled "French Notions on Accumulator Traction," reference was made in the REVIEW to the system proposed by M. Paul Gadot. Under the title of *La Traction Electrique et la Traction Animale des Tramways*, M. Gadot has now published a book of some 140 pages, dealing with storage battery and horse traction in so far as they relate to the tramway system of Paris, but he considers that his figures and conclusions are also applicable in other cases. Some of the particulars given in the work are sufficiently interesting to merit reproduction.

It appears from the statistics prepared by the Paris General Omnibus Company, which works nearly the whole tramway system in that city, that the average daily journey made by each car during the past six years was about 58 miles, but the author assumes, for the sake of convenience, 62 miles per car per day. This distance is traversed by a car carrying 50 passengers on an ordinary tramline and requiring an average tractive power of about 22 lbs. per ton hauled, even on slight gradients and round curves. Two methods have been proposed to solve the question of storage battery traction. The first consists of a self-contained car, and the second an electric locomotive containing the motor, cells, gearing, &c., and which is coupled to the car. M. Gadot bases his calculations in each case for a tramline requiring twenty cars in regular operation, and five as reserve, or a total of twenty-five cars.

THE SELF-CONTAINED CAR.

The author deals with a car requiring either one, two, three, four, or more sets of cells for a daily journey of 62 miles; but the first-mentioned is considered impracticable owing to the excessive weight of the batteries which would be necessary to supply sufficient current for a day's work. After allowing for all working expenses at the depôt, drivers' wages, maintenance of batteries and general plant, interest on invested money, &c., the cost of traction per car kilometre comes out as follows:—

Sets of cells per car per day.	Cost per car kilometre.	Cost per car mile.
2	·536 franc.	$6\frac{5}{8}$d.
3	·507 „	$6\frac{3}{16}$d.
4	·502 „	$6\frac{1}{4}$d.
5	·505 „	$6\frac{3}{16}$d.

The arrangement of three sets of cells for each car daily is considered as the best. The average discharge of the cells with four sets would be very high, and in the case of five sets the discharge would be so excessive that the plates would be worn out so rapidly as to increase the cost per car kilometre.

THE ELECTRIC LOCOMOTIVE.

In this case an electric locomotive is coupled to an ordinary tramcar, and the motor, cells, gearing, &c., can be arranged on the former as desired. This arrangement could, however, only be adopted on those lines which are level, or which have very light gradients. M. Gadot has, of course, come to the conclusion that one set of cells could not possibly be carried to provide current for one day's work, as in the case of the self-contained car. With two sets of cells daily for each car, the cost per car kilometre, after deducting working expenses and other items enumerated in the first mentioned method, is estimated at ·607 franc, or 7½d. per car mile, whilst with more than two groups of accumulators the cost would be greater, owing to the extra labour, &c., involved. The author concludes that notwithstanding the convenience of the electric locomotive, it would only be employed in preference to the self-contained car on lines having very light gradients, and under special circumstances.

M. GADOT'S SPECIAL ARRANGEMENT.

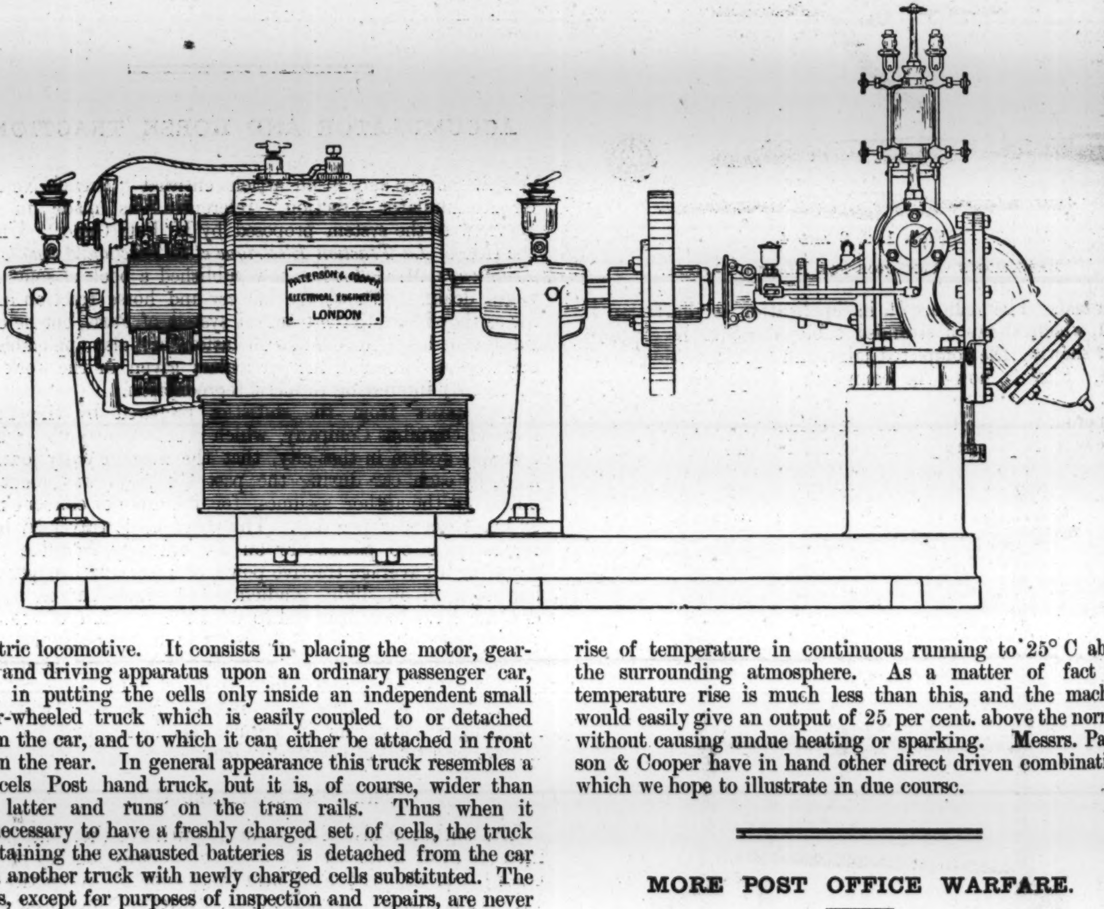
M. Gadot has patented a special arrangement which he claims to be an improvement upon the self-contained car or electric locomotive. It consists in placing the motor, gearing and driving apparatus upon an ordinary passenger car, and in putting the cells only inside an independent small four-wheeled truck which is easily coupled to or detached from the car, and to which it can either be attached in front or in the rear. In general appearance this truck resembles a Parcels Post hand truck, but it is, of course, wider than the latter and runs on the tram rails. Thus when it is necessary to have a freshly charged set of cells, the truck containing the exhausted batteries is detached from the car and another truck with newly charged cells substituted. The cells, except for purposes of inspection and repairs, are never removed from the trucks, but are charged in their place.

A service of 20 cars, with five as reserve, is estimated with this method as in the two previous systems. One group of cells for a day's work is considered impracticable, whilst with more than one set, and after making allowances, as in the other systems, the cost per car kilometre is estimated as follows:—

Sets of cells per car per day.			Cost per car kilometre.			Cost per car mile.
2	...	...	·551 franc.	...	...	7d.
3	...	...	·507 „	...	...	$6\frac{3}{16}$d.
4	...	...	·491 „	...	...	$6\frac{1}{8}$d.

In this system, also, the arrangement of three sets is regarded as the most suitable; with four sets the discharge of current would be forced, and above four it would be so great as to place this method out of the question. M. Gadot claims that his system is superior to the two others, that it possesses the same advantages as the electric locomotive without having the defects of the latter, and that it could be applied with great advantage to existing cars without requiring great expenditure.

M. Gadot states that for the Paris tramways electric traction would cost 17 per cent. less than horse traction, and that by its adoption a saving of about £42,000 per annum would be effected. The average cost of horse traction in Paris during six years amounted to ·561 franc per car kilometre.



DIRECT-DRIVEN PHŒNIX DYNAMOS.

WE illustrate above one of the direct-driven dynamos for ship-lighting, designed by Messrs. Paterson & Cooper, and referred to in our summary of their year's work a fortnight ago. The machine gives 92 ampères at a pressure of 100 volts, running at 550 revolutions per minute, is compound wound, and coupled to an 8-inch "Tower" spherical engine. Four of these were supplied to a firm of shipbuilders during the year, to be placed in duplicate on two large steamships, and were constructed to a rigid specification limiting the rise of temperature in continuous running to 25° C above the surrounding atmosphere. As a matter of fact the temperature rise is much less than this, and the machine would easily give an output of 25 per cent. above the normal, without causing undue heating or sparking. Messrs. Paterson & Cooper have in hand other direct driven combinations which we hope to illustrate in due course.

MORE POST OFFICE WARFARE.

Higher Officials. The Letter Sorters, Postmen, Telegraph Clerks, and Savings Bank Clerks !!

THE sequence of Post Office catastrophes is now complete, and the unsettled state of affairs existing in the Savings Bank Department leads us to ask if ever there was such an unfortunate Postmaster-General as the present holder of that office? We think not. Shortly after Mr. Raikes's accession to St. Martin's-le-Grand, he came into sharp collision with some of the "higher officials" on the subject of the promotion of an official in the higher ranks of the Department. This ill-omened preliminary, it may be remembered, was brought before the House of Commons, on which occasion the Postmaster-General stoutly vindicated his selection, declined to be dictated to, and, indeed, made but slight efforts to hide the hostility of "higher officialism." Since then, whatever tension may have existed has been removed, and cordial relations appear strongly in evidence, at the present time cemented, it is not unlikely by the well-advertised, if somewhat tawdry, loyalty which marked the Postal Jubilee of 1890. In the present state of affairs, it may be advisable not to overlook this forerunner of so much subsequent trouble, for it is not altogether impossible that in this direction may lie some of the factors which have contributed to the recent unprecedented course of post office turmoil and disaffection. After the friction mentioned above, and the example being to some extent set by superior officials, in quick succession followed the letter sorters' movement, the great upheaval in the Telegraph Service, afterwards the ill-managed postmen's agitation and strike, and completing the sequence there is now the so-called "Lock-out" in the Savings Bank Department. Thus the Postmaster-General has had no less than five phases of official and departmental warfare to encounter and obviate.

Whether he has been successful or not is a matter on which there is a great difference of opinion, and it may be that his tactics, as well as those of his colleagues, have at the most been but partially successful in restoring order and subordinate harmony to his gigantic and, it may be, overgrown departments.

Commercial men, following these outbreaks with a business mind, may be disposed to come to the conclusion that there is something radically wrong in the administration of business connected with the Post Office.

When men enjoying the fairly comfortable social and professional position of—to use an expression culled from the conciliatory speech of Sir Arthur Blackwood to the Savings Bank clerks last Thursday week—the "gallant English gentlemen of the Savings Bank," find it necessary to vindicate their position and privileges in the way they have done, there is certainly some ground for looking upon their action as confirming, and in a measure substantiating, the causes of recent disaffection in other departments.

We need not recapitulate the circumstances attending the so-called "dispute in the Post Office," nor need we traverse ground already broken by contemporaries; but there are a number of points on which nothing has been said. It has been said, and it is no doubt true, that employers of skilled and unskilled labour must on certain and sometimes unexpected occasions demand extra exertions and sacrifices of time from their *employés*. Going a step further, we may say that it would be folly to question the absolute dependence of commercial success on the prompt overcoming of such crises. Much, of course, depends on the way in which special services are solicited and exacted, and though it is not for a moment to be supposed that we are anxious to uphold or commend the action of the Savings Bank clerks, it appears to us that the framing of the order, intimating the infliction of compulsory extra duty or overtime, was a shade worse than injudicious. It seems practically to have courted the reception with which it was met.

Much as has been said against the Savings Bank clerks, we have to remember that Sir Arthur Blackwood himself speaks of them as even more than respected colleagues, and, under the circumstances, the effect of his arbitrary and despotic injunction requires little imagining. Overtime is positively abhorred by many members of the Civil Service, and this dislike extends well into the higher grades. It surely seems an unfair thing to tell people, who, though in no way lacking in official zeal, yet have, for the whole term of their service, politely declined to accept overtime, that their abstention from it on a particular occasion, especially under short notice, will be regarded as a case of glaring insubordination, and treated accordingly.

We suppose most of our readers have made themselves acquainted with the order we speak of. It is not unreasonable to suppose that such a method would hardly be the one adopted or recommended by the principals of independent corporations, whether banking or mercantile. May it not be supposed that even savings bank clerks are amenable to the instincts of courtesy and kindness. We find it so, at all events, much lower in the labour scale. The display of tact which might naturally have been expected from such a galaxy of well-bred and well-paid officials as those by whom the Postmaster-General is surrounded was, on this occasion, conspicuous by its absence; at all events we, in common with many others, have failed to discover it.

In the course of his speech on Thursday week, Sir Arthur Blackwood subscribed, in no uncertain terms, almost a fresh article to the Civil Servants' confession of Faith. "Obedience was the first duty of the servant of the State." This is no doubt a remodelling of the "Queen's Military Regulations," by one of which military men are reminded that "The first duty of a soldier is obedience."

Now, though such rules and regulations define the duty of a soldier, and prescribe all kinds of consequences in the event of their being breached, yet it does not prevent their being occasionally disregarded and overridden by discontented and sometimes badly-treated sons of Mars and Neptune. Speaking in a collective sense, tact and kindness have prevented more breaches of military and naval regulations than have retributive and exemplary punishments, if we may believe those best qualified to know. In this direction it may not be uninteresting to our readers parenthetically to mention one case, that of the English war ship *Theseus*, which, manned by a disaffected and refractory crew, joined Nelson's squadron just about the time of the blockade of Cadiz in 1797. The brave little rear-admiral shifted his flag from the *Captain* to the *Theseus*, and his kindly personal influence and command were so possessed of that magnetic charm which becomes contagious that not only did discontent quickly disappear but, as was usual with Nelson's crews, feelings of affection sprung up, and the men of the *Theseus* proved themselves the equals of Nelson's famous "Agamemnons."

As if to pledge themselves to good works, a note from the crew of the *Theseus* reached Nelson mysteriously one night, containing the following moving sentences: "Success attend Admiral Nelson! God bless him and Captain Miller! We thank them for the officers they have placed over us. We are happy and comfortable, and will shed every drop of blood in our veins to support them, and the name of the *Theseus* shall be immortalised as high as the *Captain's*.—Signed Ship's Company." Nelson felt nearly as proud of this as he did of the Order of the Bath, which he received about the same time.

Harking back, however, to the postal struggles of the last few years, it is likely enough that the nation does not wish its civil servants to be governed by rules similar to those which control recalcitrant marines and disorderly militia men.

For one thing, the soldier and the sailor are under service every minute of the twenty-four hours, but this is not the case, it is almost needless to say, with our Civil Departments. The Savings Bank clerks have properly expressed regret for their conduct; no doubt, as they urge, they did not think so serious a view would have been taken of their conduct. It is also a matter for regret that an appeal couched in the conciliatory terms of Sir Arthur Blackwood's speech on the Thursday following the *contretemps* was not delivered on the Thursday preceding it.

Its object would have been fully attained, and its moral effect would have been at once satisfactory and permanent. Placed in juxtaposition to each other, the autocratic secretarial mandate, and the semi-socialistic secretarial oration, display, in a most striking way, the extremes of administrative resource, the positive and negative of departmental control. One of the conclusions to be drawn from the episode is that possibly an increase of the staff in the Post Office Savings Bank Department would prove beneficial to the public service.

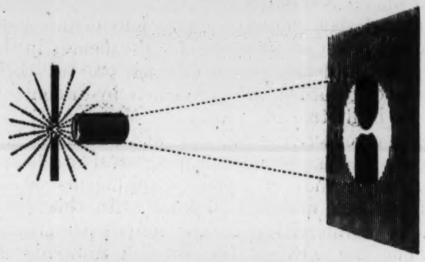
TESTING ARC LAMPS.

By FRED. H. COLVIN.

THERE is in use at the main Brush Electric Light Station, Philadelphia, an ingenious and praiseworthy arrangement for testing the arc lamps before they are sent out, or on repair work. It is praiseworthy because it saves the eyes of the workman, and ingenious because of its novelty.

The testing rack is of the usual form, but in front of each lamp is placed a lens which is provided with a rack and pinion focussing arrangement, and fitted in a horizontal sliding way or frame so as to be readily adapted to each carbon.

The lamps to be tested are switched on as usual, but the operator, instead of watching the carbon points themselves, adjusts the lens to focus on the white wall several feet away, and there watches the enlarged and inverted image of the carbons in all their processes of burning, and sees much more accurately than if he watched the carbons themselves. This does not injure the sight to any perceptible degree, and is not only humanitarian, but gives a clearer idea of the action of the carbons.



SIMPLE METHOD OF TESTING ARC LAMPS.

The accompanying figure, from the New York *Electrical Engineer*, will illustrate the plan quite clearly.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

13,389. "Improvements in electro-magnets and in their application to arc lamps." H. HARPER. Dated August 24th. 8d. The outer or "series" coil, composed of coarse wire, consists, by preference, of several coils arranged in series and wound upon a lining tube, which may be of brass. The inner or "parallel" coil is composed of fine wire, and is also wound upon a brass lining tube. The lower end of each tube is formed or furnished with a collar for carrying the weight of the wire. The upper extremity of the inner tube is fastened direct to a metal carrying plate; the upper extremity of the outer tube being secured, by means of a flange and through the intervention of a vulcanite disc, to the same carrying plate. 5 claims.

19,079. "Improvements in electrical cut-outs." F. BRYAN. Dated November 27th. 6d. The inventor uses a conducting wire strip or foil arranged as a shunt or bridge across or between the points where the circuit is to be broken to avoid sparking. 1 claim.

19,450. "An electro-motor worked by alternating currents." M. LEBLANC. Dated December 3rd. 8d. Claims:—1. In an alternating current electromotor the combination of an armature and a coiled ring provided with collector and brushes revolving synchronously with the generator of the alternating currents, substantially as described. 2. The described method of transmittiug by the same conductor the continuous currents for exciting the inductors of the machines and the alternating currents for their armatures, and of separating these currents at the place of their application into two branches, the one for the inductors including a coil of small resistance but high self-induction, the other for the armatures including suitable condensers.

19,813. "Improvements in the methods and apparatus employed in the heating, melting, and working ef metals, alloys and metalloids by the application of electric currents." J. C. WERNDLEY and H. FOSTER. Dated December 10th. 11d. The inventors make use of a dynamo or other suitable electrical generator for the formation of a voltaic arc where required, and further introduce into the electrical circuit the metal, alloy, or other article to be heated, melted, or otherwise operated upon in such a manner that a voltaic arc can be formed at any desired point on the article, either by the approach to each other of two or more carbons or other suitable bodies forming the positive and negative pole of the circuit respectively, or the metal or other article to be heated, melted, or otherwise operated upon, may itself form one pole of the circuit, while one or more carbons or other suitable body forms the other pole. In the union of metals or alloys, either in layers or otherwise, to themselves separately or to each other, they connect a cable or other suitable conductor to the article to be operated upon, and also to the negative pole of the dynamo or other electrical generator used. They then connect one end of a similar cable or other conductor to the positive pole of the dynamo or other electrical generator, and to the ether end of this cable they fix a carbon or other suitable body having an insulated handle attached, and by which it can be moved about as desired, without danger to the operator. 4 claims.

20,022. "A bi-planar electric switch." E. WILSON. Dated December 12th. 8d. The inventor pivots a semi-circular ring at the ends of its diameter, so that it can oscillate up or down on a horizontal axis, and he pivots in like manner another semi-circular ring, so that it can oscillate to right or left on a vertical axis. One of the semi-circles is smaller than the other, so that it is free to move within the other. To both semi-circular rings he attaches a switch handle, by guides, so that the handle can be slid along either ring carrying the other ring with it. On each side of the middle point of each ring (that is to say, the extremity of a radius perpendicular to the vertical plane of the four pivots) at some distance from that middle point there is a contact. The switch handle can be moved to any one of these contacts, so as to close any one of the four circuits with which they are connected. 2 claims.

20,082. "A method of and apparatus for signalling numerals, letters, and other symbols by electric light." R. T. TURNBULL. Dated December 13th. 4d. At the receiving station the inventor fixes a frame, in which are mounted a number of incandescent electric lamps arranged in rows in different directions, such that by illuminating several of these rows in combination or succession, groups of lights are presented, having approximately the shapes of the symbols that are to be signalled. At the sending station he provides a suitable electric generator and commutator connected by conductors with the receiving apparatus, and by means of this commutator he transmits currents in such combinations or successions that only the lamps of the particular rows forming the desired symbol become lighted. 2 claims.

20,582. "Improvements in electric meters and indicators." J. EINSTEIN and S. KORNPROBST. Dated December 21st. 8d. A revolving body communicates motion through the intervention of an intermediate piece, to a registering device the ratio of the effective diameter of the revolving body to that of the intermediate piece being varied according to the strength of the electric current, the speed of rotation being correspondingly varied either directly through the current to be measured by means of a solenoid, or indirectly through a branch current, in which are interposed two oppositely acting electro-maghets. 4 claims.

20,645. "New or improved means for protecting the metallic coating of telegraph cables from corrosion." J. A. L. DEARLOVE. Dated December 23rd. 4d. The inventor coats the metallic strip with what is known as anti-sulphuric enamel, or other suitable enamel, varnish, or adhesive protecting material, by passing the said strip through a bath of the material, removing the surplus by means of suitable brushes or "doctors," and he then drys the protecting material on the strip by passing the latter, when coated, as above described, through a steam jacketed cylinder or other heated chamber. 2 claims.

20,646. "A new or improved printing telegraphic apparatus." G. A. CASSAGNES. Dated December 23rd. 1s. 1d. The object of the apparatus is to receive the electrical signals transmitted from a distance and to translate them into typographic characters printed upon a paper tape, as fast as the transmission proceeds. The principle of the method consists in placing at the receiving station a number of electro-magnets equal to the number of keys which are to be combined together at the transmitting station, and in arranging these electro-magnets in such a manner that the attraction of their armatures will produce by means of proper mechanism, such angular displacements of a type wheel as are determined by the number of electro-magnets in action; so that the depression of any key, or that of any combination of keys, will bring immediately, under the printing pad, the division of the type wheel whieh bears the letter or the group of letters, to be printed on the tape. 8 claims.

CORRESPONDENCE.

Electric Light on Shipboard.

Mr. Rankin Kennedy's letter published in your issue of the 19th ult., seems to me to be somewhat beside the mark. In his previous letter he stated that lead covered wire without continuous vulcanised rubber insulation was a failure on board ship, and in reply I pointed out that this was not the experience of the English Admiralty or of Messrs. Sir W. G. Armstrong, Mitchell & Co.

All questions of insulation must in practice be reduced to a compromise between cost and absolute excellence, and it is obvious that materials which from an absolute point of view may be the best, may for financial reasons be practically precluded. The true question to be decided is what form of insulation and protection is good enough to give really satisfactory results at a minimun cost, and I can only reiterate my opinion that lead sheathed cable insulated with yarn and bitumen meets these requirements very well, so far as the lighting of ships of war are concerned.

No doubt mercantile boats present different conditions, but to these I have not alluded.

I cannot agree with Mr. Kennedy when he states that well braided vulcanised rubber insulation is as waterproof as, and does nôt require more protection than the lead covered wire; but even if this were so, I would point out that the latter would still be preferable, as the smooth, even surface of the lead and the way in which it allows the cable to be bent to fit any position, and causes it to remain in that position when once bent, give the lead covered cable a great advantage where really neat work is necessary. In fact where there are many corners and bends, lead covered wiring can be made very much more sightly than wiring protected with wood casing or sheathed with iron wire.

With regard to the question of cost I may say that some years ago I went very carefully into the comparative expense (1) of vulcanised rubber insulation with wood casings, and (2) vulcanized rubber insulation with lead covering for ships of war, and found that including all labour, the latter was considerably the cheaper.

Bitumen is, of course, much less costly than India-rubber, which makes the saving still greater when lead sheathed bituminous insulation is employed.

A. A. C. Swinton.

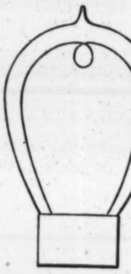
January 7th, 1891.

Curious Phenomena.

Being experimenting with some 100 volt incandescent lamps, I noticed some rather curious phenomena which I have never heard described before.

One terminal of the lamps was connected to the terminal of a shunt wound dynamo, the other terminal of the lamp was lying on and in contact with the field magnets of the machine, the brushes were raised off the commutator (the machine was not running) and 56 accumulators were connected with the terminals of the machine and were consequently sending a current round the field magnets.

On suddenly breaking the field magnet circuit the lamp lit up and went out again instantaneously; but on examining the lamp afterwards I found that the filament had opened out so that it was within $\frac{1}{8}$ inch of the glass thus :—



I can understand the lamp lighting up on breaking circuit; it was no doubt due to the induced current, as there was a slight earth on both mains leading to the battery, but I cannot understand why the filament should have been drawn to the glass.

I also find that if you connect a lamp to some accumulators, holding the lamp close to the field magnets whilst they are excited and then open and close the lamp circuit so rapidly that the filament never gets more than red hot, the filament will commence to vibrate so violently as to touch the glass, and a bright blue spark will appear at the point of contact wherever the filament does touch the glass. The higher the field magnets are excited the more violent are the vibrations, and the greater the brilliancy of the spark.

If the field magnet is opened neither spark nor vibration can be obtained.

If these are well-known facts, I shall be much obliged if you can give me any explanation of them.

H. Hewlett.

Force, Energy, Power, &c.

M. Hospitalier has justly criticised "Foot-pound's" method of showing power and work done as a volume alongside energy as a surface. It struck me, however, on reading the latter's letter, that he perhaps did not mean his representation to be taken in diagrammatic literalness, but that having shown energy as a surface, he had reverted to the volume not as a volume, but merely as something different from a surface to illustrate the next idea. The method, nevertheless, is an unsafe and misleading one, for it makes time a factor of work. No doubt when the work done per second (or the power) is known, the work done in a given time is got by multiplying the second's work by the seconds in this given time; but the time idea is merely accidental here, and not essential; it is used simply as a means of arriving at the total work done, the notion of which as pure work does not involve the idea of time at all.

Similarly, the Board of Trade unit is rightly spoken of as a fixed quantity of work or *energy*, for 1,000 watt-hours = 1,000 × volt × $\frac{\text{coulomb}}{\text{second}}$ × 60 × 60 × second, the seconds cancel, and we have volt-coulombs or *joules*.

It would have been more consistent had "Foot-pound" taken the lb. (weight or force), gramme (of water), or coulomb as a unit, shown by an upright line of fixed length, and the feet, degrees Centigrade, or volts, by a horizontal line of indefinite length. The completion of the rectangle at the point marking a given number of feet, degrees, or volts would then show the work done therein. Underneath could be drawn another horizontal line for time, the unit being indicated by the point where a perpendicular, dividing off work done in unit time, cut this line. M. Hospitalier says that power is not the work produced in the unit of time, but this is exactly what it is, being, in fact, work *divided by* time, *i.e.* work *per* unit of time, whatever may be fixed on as such. "Foot-pound" also makes E t' (energy × 1 second = power, whereas it should be $\frac{\text{energy}}{\text{seconds}}$. The numerical result in the case of one second (as he takes it), is, of course, the same either way, but it would not be so if time exceeded units. Thus the rectangle cut off to the left by the time-unit perpendicular referred to, would show power, and the whole rectangle would stand for work done, apart from connection with the time line underneath.

Jas. McLachlan.

I fully admit the accuracy of Mr. Hospitalier's criticism of my diagram considered as a scientific exposition. Energy and work being really the Dr. and Cr. sides of the same account, should of course, strictly speaking, be represented by the same means (*i.e.*, both as solids or both as superficies). It was not, however, a scientific exposition that I intended; the hybrid diagram being merely meant as a visible peg whereon to hang remembrance, in which respect I still think it suitable and convenient.

A desire not to tresspass on your space unduly, and a somewhat hasty writing of my letter have, I see, caused me to be hardly sufficiently explicit, and with your permission I will now add a word or two to my previous description.

To anyone at all acquainted with the subject, it is of course evident that *power* is not energy × unit time; the *mumerical expression* of power, however, is the numerical expression of energy developed *per* unit time. Thus, taking the pound, foot, and minute as units of force, distance and time, respectively, if force = 330 and distance = 100, then energy = 33,000 foot-pounds, and, if this amount of energy is developed evenly in the course of one minute, then a power of 33,000 foot-pounds per minute (for convenience only called one H.P.) is at work. The continued exercise of this power for *n* minutes (t^n) does "solid work" to the amount of 33,000 × t^n foot-pounds.

In the equations printed under the diagram "E t' = power" should have been written "E per t' = power."

The Foot-Pound.

January 12th, 1891.

The City and South London Railway.

With reference to your editorial note at the foot of the article regarding the commercial prospects of the above undertaking, I have endeavoured to ascertain how much of the 50 per cent. on other railways is taken up in motive power expenses only. In the Board of Trade Railway returns figures are given regarding the total expenditure for locomotive power, but no distinction is made between the expenses incurred in the haulage of goods trains and those involved in passenger train traction. Moreover, I am informed, on good authority, that even the railway companies themselves are not aware of the exact ratio which the one bears to the other. You will therefore see that it is impossible to obtain the information you desire.

The complaints made by Mr. Mackenzie-Ledlie, reproduced in the last issue of the REVIEW, are mostly well founded; but I must take exception to the statement that the "ventilation at best is excessively poor." I found when travelling on the trains the other day that instead of the ventilation being poor there was too much of it; but this and other defects will doubtless be remedied in due course.

The number of passengers on the train when leaving King William Street Station on Saturday last at 11.30 a.m.—a busy time—was 27, and two additional passengers entered the train at the Elephant and Castle. On my return journey from Stockwell, at 12.15 p.m., there were 33 passengers on board, whilst four others were picked up at other stations. On both occasions there were about 15 persons who from their behaviour I concluded were travelling for the sake of curiosity.

A. Willbond.

London, *January 12th*, 1891.

I shall be obliged if you will kindly insert the enclosed copy of a letter which I have addressed to the *Electrician*.

Yours faithfully,

A. Willbond.

[COPY.]

THE CITY AND SOUTH LONDON RAILWAY.

To the Editor of the *Electrician*.

Sir,—In the last issue of your journal you state: "During the first 14 days, ending on Saturday last, the receipts amounted to £1,947, showing that 233,640 passengers had been carried during that period, or on an average 16,688 per day; that is to say, nearly 40 per cent. more than was estimated by the pessimistic Mr. A. Willbond." This is all very well in its way, and might have passed muster amongst your readers were it not for the extraordinary fact—which seems to have escaped your attention in making up—that you have yourself discounted your own figures by stating that it must "be borne in mind that novelty is only a temporary attraction, and that comfort and regularity will alone secure permanent patronage."

The figures given by me in the ELECTRICAL REVIEW were based upon permanent traffic, and I have found when travelling on the railway that the actual number of passengers carried was, on several occasions, only a *very small* percentage higher than given in my estimate. "It is, moreover, to be borne in mind that novelty," which "is only a temporary attraction," was at that time still temporarily attracting.

I hope that your readers who have read the two leaderettes in question will find my letter at last a "temporary attraction."

Yours truly,

A. WILLBOND.

London, *January 13th*, 1891.

P.S.—When about to post this letter, I find that the official returns for last week's traffic give the total receipts as £748. Thus, notwithstanding the "temporary attraction," the average number of passengers carried per day was only 12,823, or about $7\frac{1}{3}$ per cent. more than the number given in my estimate.

Is Science Disciplined Knowledge, or is it Something Else?

I find that I omitted in the foot note to my last communication certain matters I desired to emphasise. In the extract which was given, Sir William Thomson refers to what he has termed "the known laws of diffusion of electric currents through non-magnetic conductors." What I wanted to direct attention more especially to was, that it seems to me that there can be no absolute law, and consequently no "known laws," each conductor through which transient currents are being transmitted having its own specific capacity. The specific capacity of soft iron to occlude energy is greater than that of tempered steel, and very much greater than that of copper; but no two samples of iron have precisely the same capacity, and similarly different samples of copper do not behave exactly alike. Soft pure iron not only occludes more energy when it forms part of an electric circuit than tempered steel does, but it parts with a greater percentage of such occluded energy at the time the circuit is opened, and copper conductors would seem only to have the power to occlude energy so long as an electric circuit is closed through them. The shape of a conductor also affects its capacity to occlude energy, the specific capacity of a conductor in the shape of a ribbon being less than that of the same amount of material in the form of a cylinder, and the capacity which a straight cylindrical conductor possesses to occlude energy is very much less than that of the same conductor when in the form of a helix or a solenoid.

An excited electrophorus may be regarded as the electrical analogue of a tempered steel magnet, and a Leyden jar, constructed of pure flint glass, may be considered to be the electrical analogue of very pure soft iron rendered temporarily magnetic.

It is almost impossible to completely discharge an electrophorus, and it is very difficult to completely demagnetise a tempered steel magnet. A Leyden jar made of flint glass, however, discharges very completely, but at the same time not absolutely, and soft pure iron parts with magnetism very completely, but also not absolutely.

Magnets and charged Leyden jars resemble one another in the fact that they are both of them examples of a statical occlusion of energy, and it may be said of them that they comport themselves alike, and also differently; place a piece of iron in the lines of force connecting the north and south poles of a magnet, and it becomes magnetically polarised; and, similarly, if matter be placed within the lines of induction of a charged Leyden jar, it becomes electrically polarised; but electrical polarisation occurs *only* through a path of matter, whereas magnetisation can take place through absolute space. Now, the occluded energy of a Leyden arrangement, and also that of a magnet, cannot perform work, but it can form a fulcrum for mechanical force to act upon (in one case in matter and in the other in space), and by the expenditure of mechanical force, work can be done—influence machines and dynamos are cases in point.

Physicists talk of the rate at which electricity travels; my contention is that electricity does not travel. In a closed circuit, such as that of a dynamo, it may be argued that the electricity forming part of the matter of the dynamo circulates round and round, but not so in the case of a lightning discharge or that of a Leyden jar, where there is no circuit, but only a path.

I think I am now in a position to point out a source of error which our physicists, it appears to me, have fallen into, and possibly Maxwell himself also, they seem to have confused both electricity and light with energy; neither light nor electricity is energy; light, it is contended, does not travel from the stars through space, but simply energy, and such transmitted energy develops light when it comes in contact with matter; energy is also concerned in all electrical phenomena, and it is energy, not light, that travels at the rate of 192,000 miles per second.*

It may be said I am coming round to the newer theory—in a sense, but only in a sense, this is true. I have arrived at my present position by correcting what I conceive to be the errors of our physicists, and I am pleased to arrive at some common ground of argument.

My criticism throughout has been almost exclusively confined to the elucidations of Maxwell's theory by Prof. Lodge and Sir William Thomson, so far as their elucidations relate to such practical questions as the laws which govern the transmission of energy through the medium of transient electrical currents, be these currents lightning discharges, or be they alternations developed by a transformer, and I have nothing to retract from what I have said.

In the course of my communications which have appeared in these columns during the last three years, I think it will have to be admitted that I have thrown some new light on inertia and energy, and also on certain of the more elementary physical phenomena. Time will show whether I am right or wrong in what I have been contending for, but I myself am firmly persuaded that my contentions having reference to the electrical transmission of energy will be found to be in the main correct.

S. Alfred Varley.

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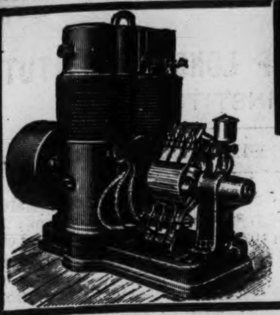
* Physicists talk of the rate at which light and electricity travel, on reflection it will be seen that it cannot be correct to do so.



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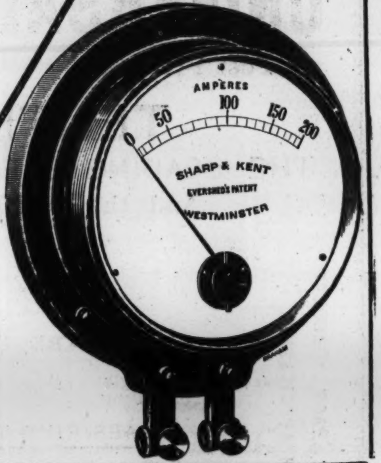

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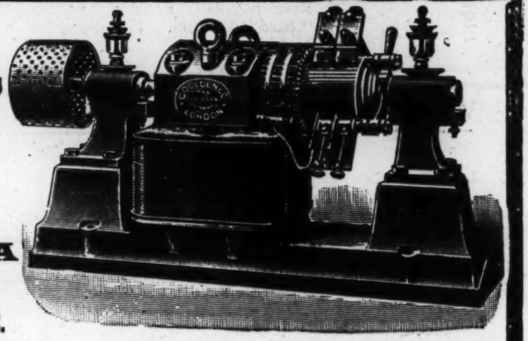

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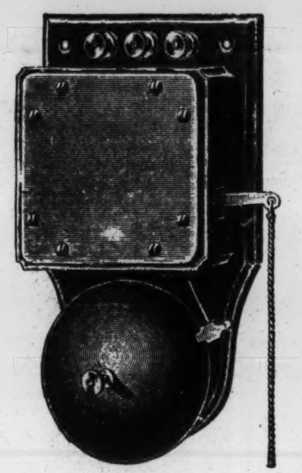

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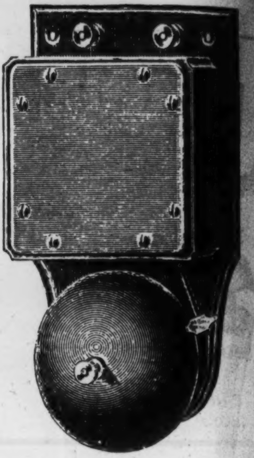

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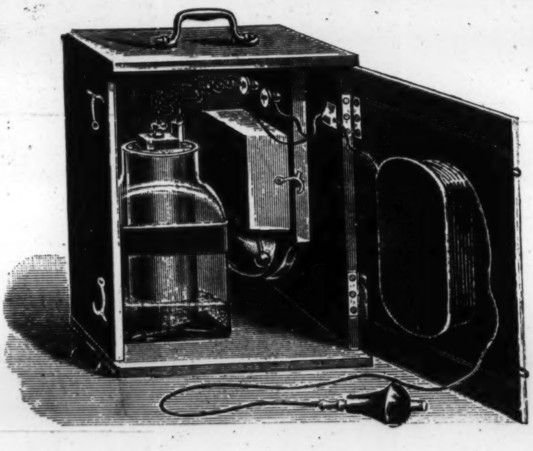

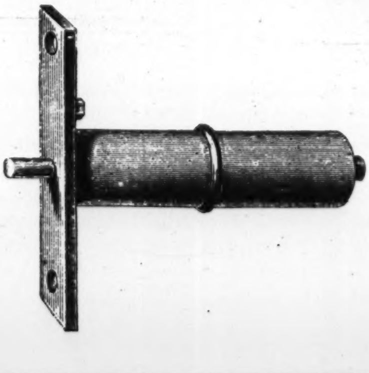

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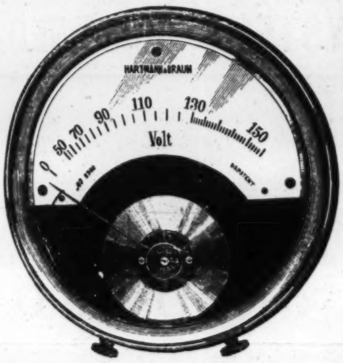

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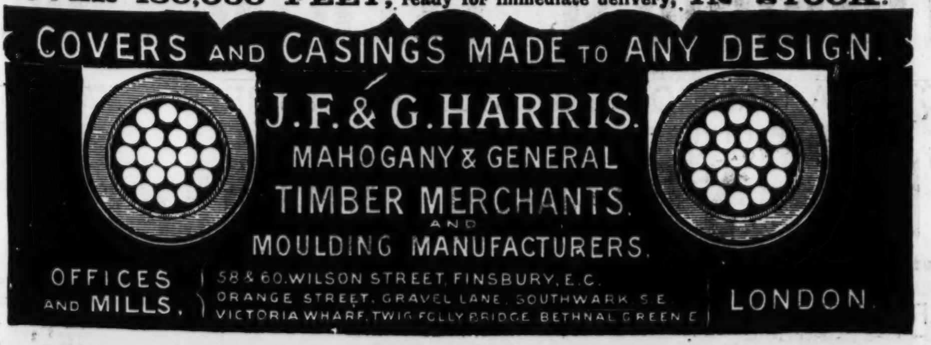

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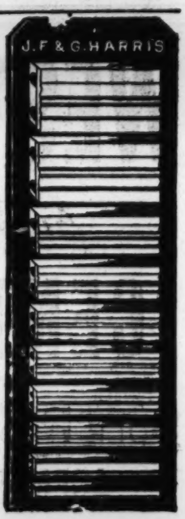

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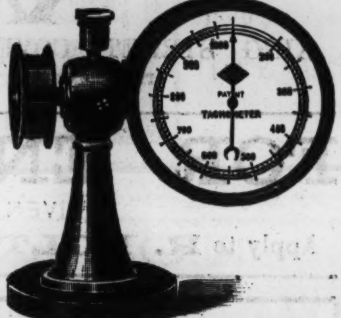

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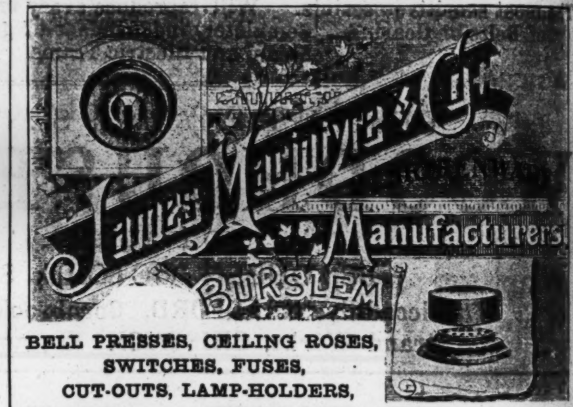

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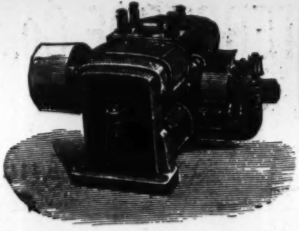

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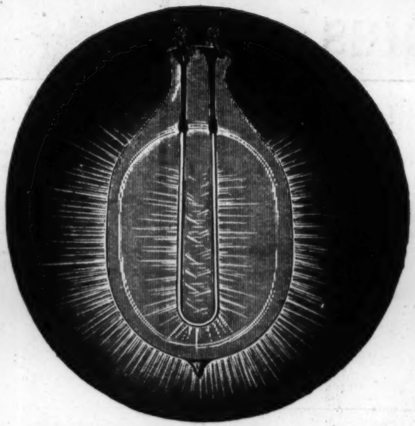

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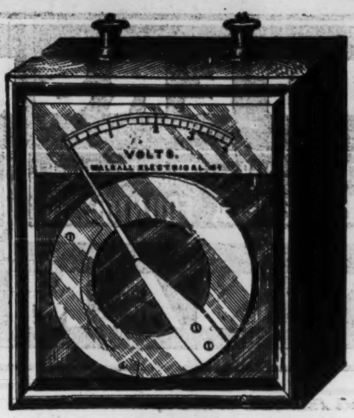

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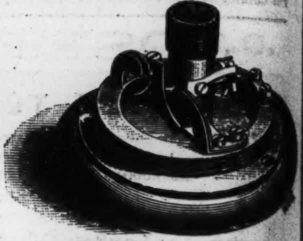

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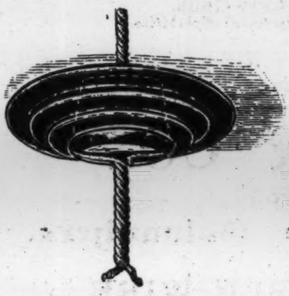

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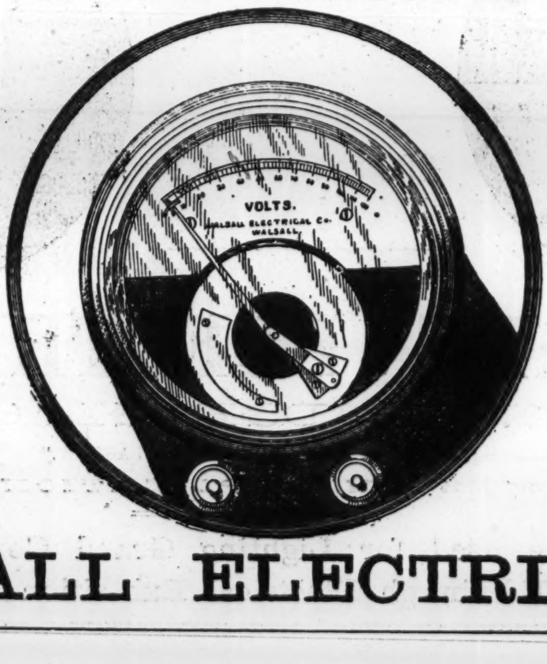

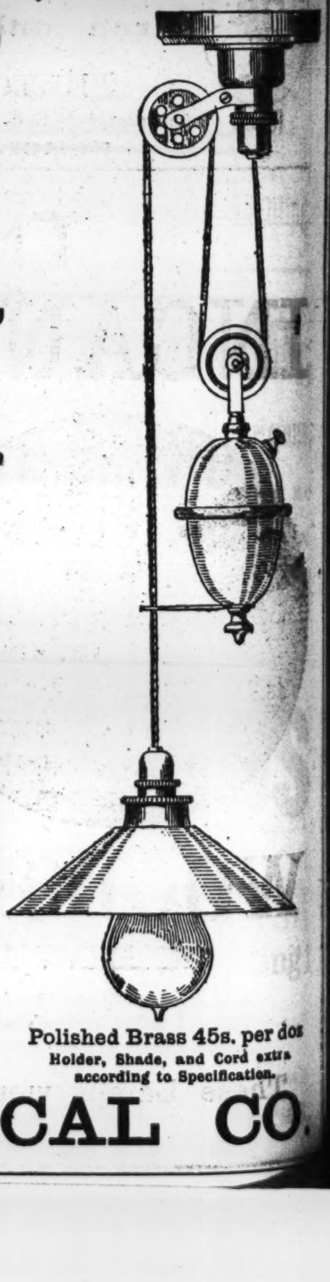

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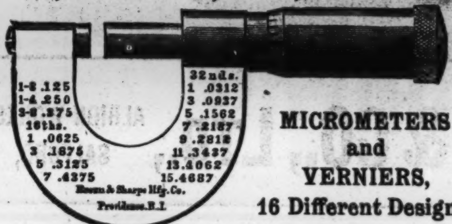

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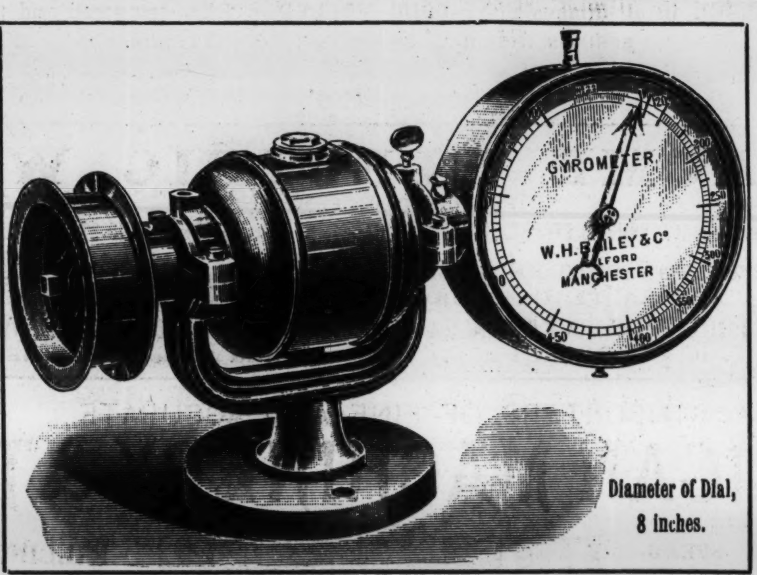

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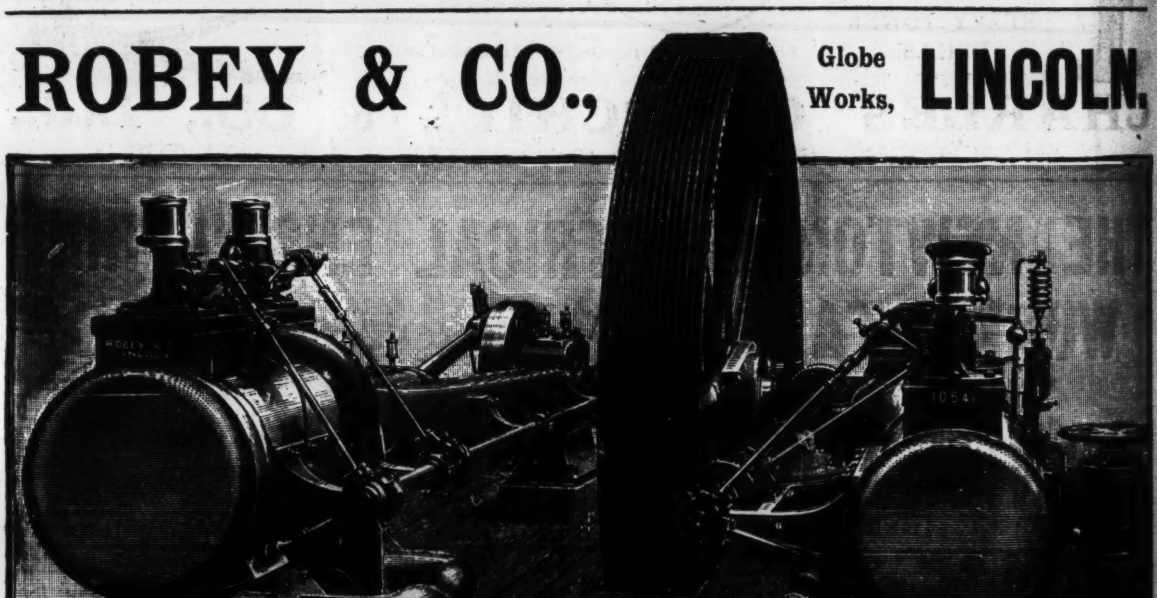

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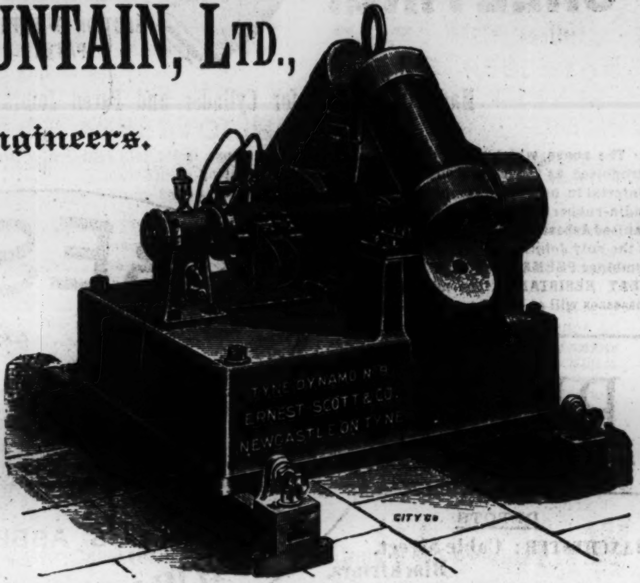

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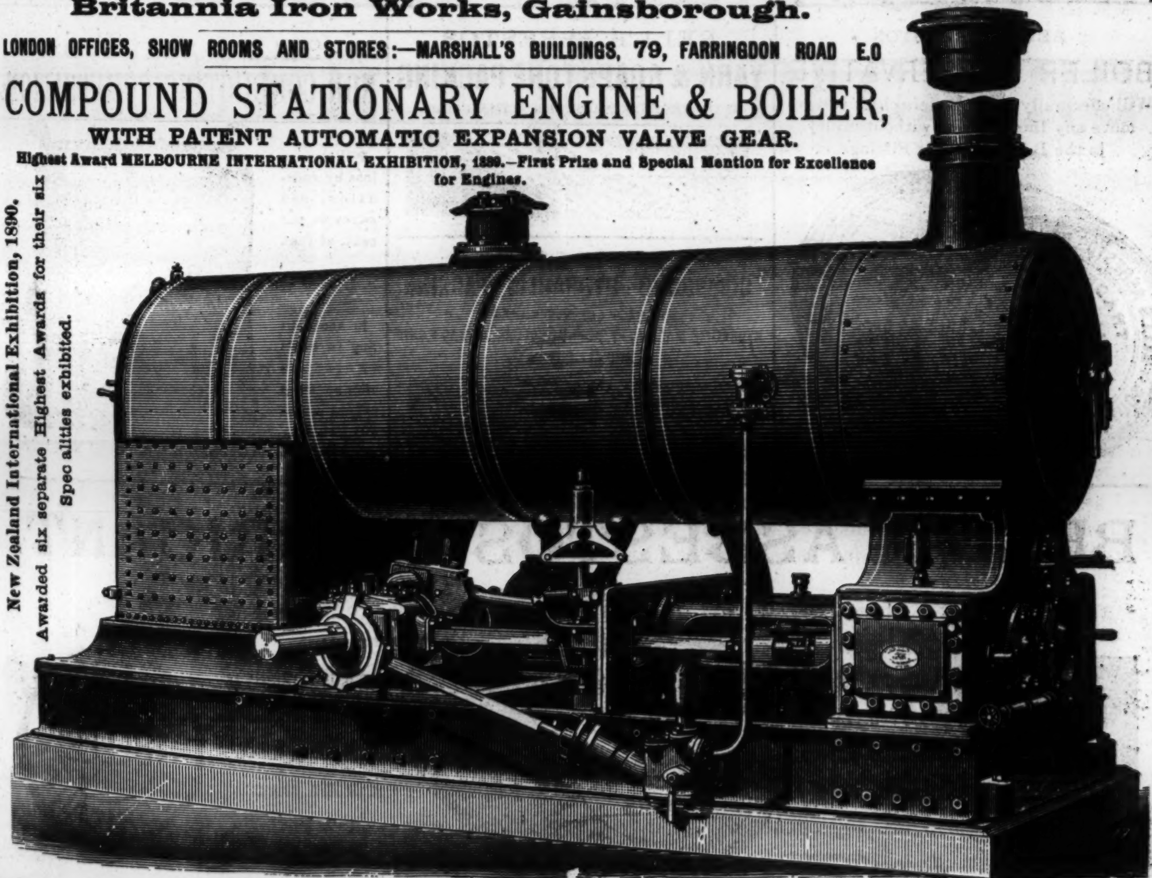

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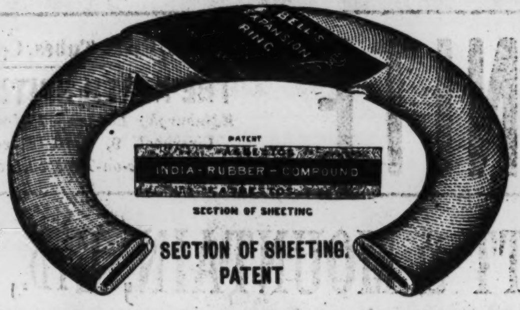

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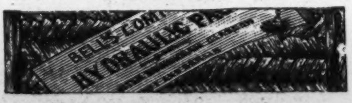

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Will reduce loss by radiation, and saves 40 per cent. of fuel.

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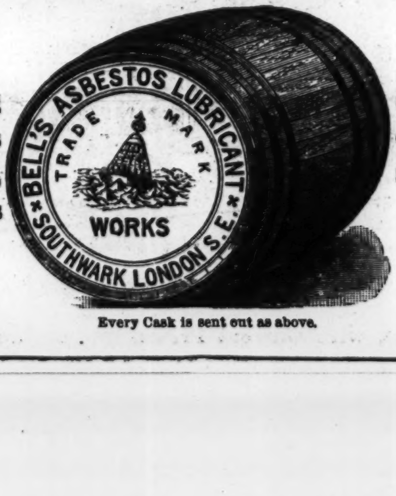

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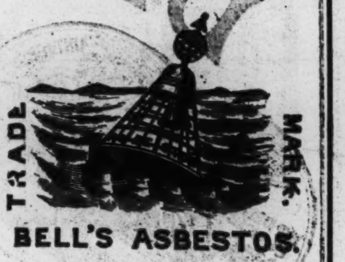

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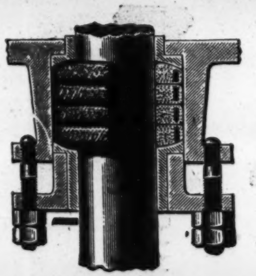

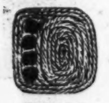

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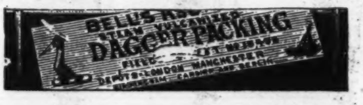

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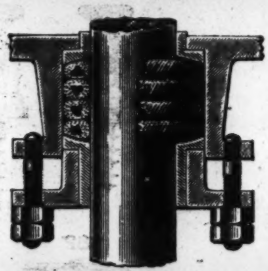

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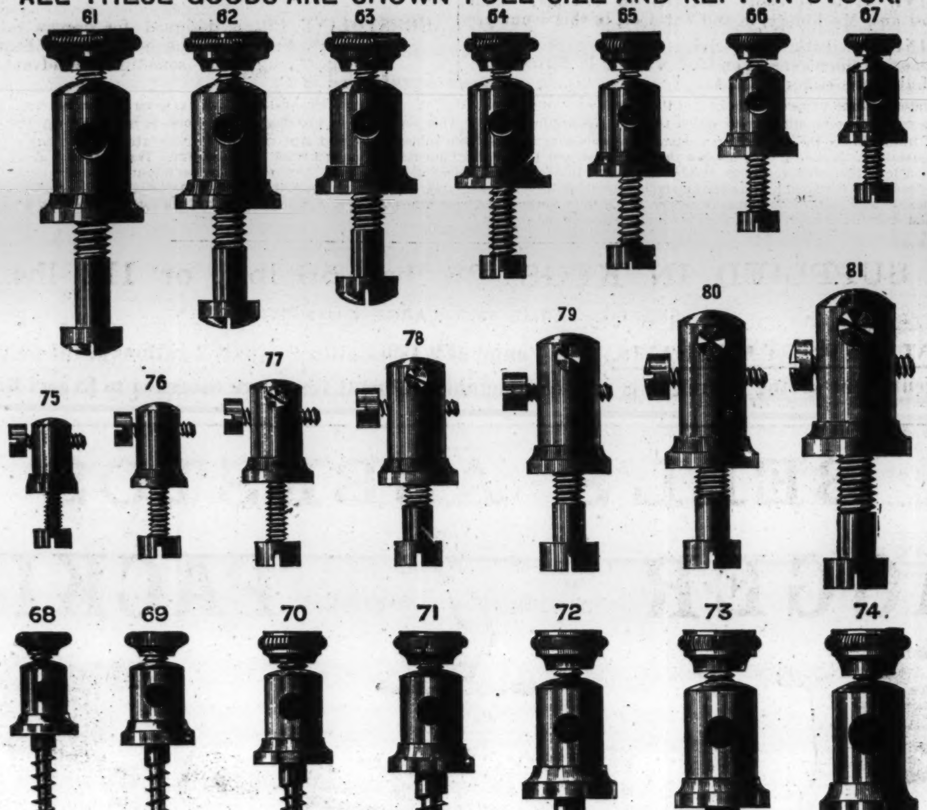

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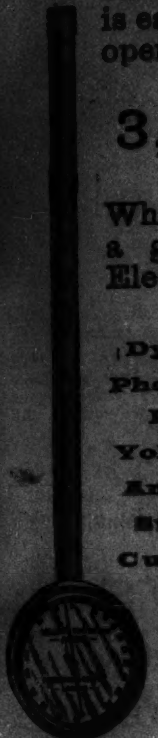
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